Environmental Conditions Update

JANUARY 2001

Environmental Monitoring and Assessment Division
South Florida Water Management District

*This issue of the Environmental Conditions Update analyzes data collected from **July 1 through September 30, 2000**. The major hydrologic event of the quarter was is September when Hurricane Gordon caused above-average rainfall in western sections of the District, Lake Okeechobee and Lower Kissimmee basins. Only minor water supply releases were made from Lake Okeechobee this quarter due to low lake levels. Lower lake levels resulted in lower than average in-lake total phosphorus concentrations and higher than average light penetration. Stormwater Treatment Area 5 (STA-5) began flow-through operations July 7, 2000. In this first quarter of operation, total phosphorus loads were reduced 59 percent.*

Environmental Conditions Update January 2001 Summary

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RAINFALL

SUMMARY

Monthly rainfall for July, August and September 2000 in various rainfall basins and stormwater treatment areas is presented in **Table 1**. The monthly rainfall totals are weighted averages of data from rainfall gages reported in the South Florida Water Management District (District) daily rainfall report compiled by Water Resources Operations and from other agencies collecting rainfall data in South Florida.

Historically the occurrence of rainfall in South Florida during the dry months (November through April) has been generally associated with occasional disturbances such as cold fronts, and during the wet months (June through September) attributed to frequent thunderstorms, tropical storms or hurricanes. May and October have been considered transitional months and can be either wet or dry.

July produced rainfall somewhere within the District every day, but there were no days of widespread heavy rain. District-wide rains averaged 7.43 inches, or 106 percent of the monthly historical average. Basin rainfall ranged from a low of 5.25 inches over Lake Okeechobee to a high of 9.10 inches over Water Conservation Areas 1 and 2. August was the driest since 1987. Overall, 4.99 inches of rain fell on the District with only eastern Miami-Dade County, the Southwest Coast and the Upper Kissimmee Valley receiving near normal rainfall. Basin rainfall ranged from a low of 2.77 inches over Lake Okeechobee to a high of 8.11 inches over the Southwest Coast. September had above-average rainfall due to Hurricane Gordon's track through the eastern Gulf of Mexico in the middle of the month. District-wide

Table 1. Monthly weighted rainfall averages (inches).

Rainfall Basin	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	12-Month Moving Total
Upper Kissimmee	6.0	2.5	2.5	1.2	0.2	0.8	1.5	1.2	6.7	8.4	6.0	4.9	41.9
Lower Kissimmee	6.1	0.9	1.7	1.2	0.2	1.5	1.7	0.5	4.4	7.8	3.4	6.1	35.5
Lake Okeechobee	5.3	0.5	1.1	1.1	0.6	1.8	3.3	0.9	4.5	5.3	2.8	7.0	34.2
East EAA	7.8	0.6	0.6	1.0	0.8	2.3	4.8	4.8	4.8	7.3	3.5	6.0	44.3
West EAA	7.4	1.0	0.4	0.9	0.9	1.6	5.1	1.6	6.1	6.3	3.9	7.2	42.4
WCAs 1&2	12.4	1.3	0.8	1.2	0.4	5.7	3.8	1.0	4.1	9.1	4.1	6.0	49.9
WCA 3	13.0	1.7	0.6	0.7	1.1	2.4	5.4	0.9	7.3	7.9	4.3	7.1	52.4
ENP	15.3	1.1	0.8	***0.4***	***0.5***	***1.0***	**3.6**	**2.0**	**6.9**	**6.9**	**5.0**	**3.9**	47.4
C111 Basin	13.3	1.5	1.2	0.6	0.9	1.6	3.6	1.9	6.6	9.7	7.7	9.1	57.7
STA-1W	12.1	0.3	0.9	0.7	0.8	3.7	4.4	0.9	1.4	10.0	2.3	6.3	43.8
STA6	11.1	1.1	0.4	0.3	1.0	2.3	3.6	0.4	4.7	11.7	3.1	10.0	49.7

Italisized and bolded values are based on estimate average of rainfall at stations CHEKIKA and S332R

rainfall averaged 6.98 inches or 108 percent of the monthly historical average. Basin rainfall ranged from a low of 4.94 inches over the Kissimmee Valley to a high of 9.86 inches over the Southwest Coast. Through September, the wet season rainfall was 25.46 inches or 88 percent of the historical average. The effects of the below-average rainfall can be observed in low inflows and total phosphorus loads entering Lake Okeechobee (**Figure 2)** and low phosphorus loads calculated for the Everglades Agricultural Area (EAA) (**Figure 6**).

LAKE OKEECHOBEE DRAINAGE BASIN

SUMMARY

MAP

Phosphorus Loading and Rainfall Trends

Historic and monthly data for rainfall, flows and phosphorus loads to Lake Okeechobee are presented for 1999 (**Figure 1**) and the first three-quarters of 2000 (**Figure 2**). In both figures, monthly values for each of these parameters are depicted as bars. Solid lines represent monthly means based on the previous 20-years of data. A 20-year period was chosen because it provided a quality-assured data set for water quality and covered both drought and wet conditions. The dashed and dotted lines in each figure depict the 95 percent confidence interval about this 20-year mean. In other words, a 95 percent chance exists that a value will fall within that confidence level. **Figures 1** and **2** display the expected range of data for the 20-year period.

Monthly rainfall shown in each of the figures is presented as area-weighted averages from a network of meteorological stations in the Upper Kissimmee, Lower Kissimmee and Lake Okeechobee basins. Flows are compiled from directly measured data at 26 monitoring stations that discharge into the lake. Phosphorus loads to the lake were calculated by multiplying concentration data from those 26 monitoring stations and their respective flow data.

The effects of the Shared Adversity Plan (Resolution No. 00-31) on Lake Okeechobee is described in the October 2000 Issue of the *Environmental Conditions Update* (SFWMD, 2000).

Higher phosphorus loads have typically occurred during wetter months (June through October), while lower loads occur during drier months of the year (**Figures 1** and **2**). In 1999, the period from June through October, excluding July, exhibited higher rainfall than the 20-year average for these months. As a result, both flows and phosphorus loads for these five months were greater than their 20-year means (**Figure 1**). Both flows and loads for June through September 2000 were lower than their 20-year averages (**Figure 2**).

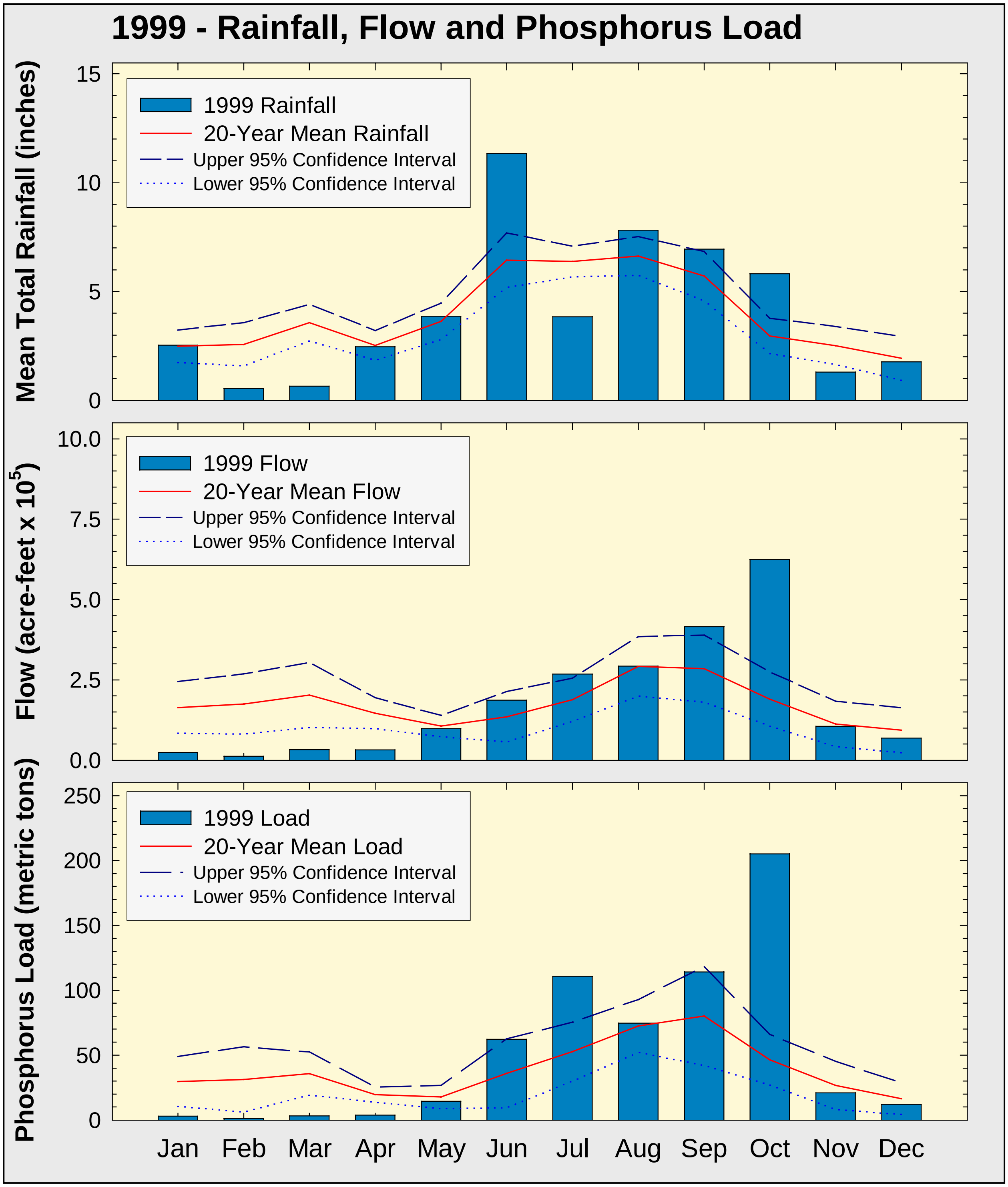

Figure 1. Monthly total phosphorus rainfall, flow and loads for Lake Okeechobee.

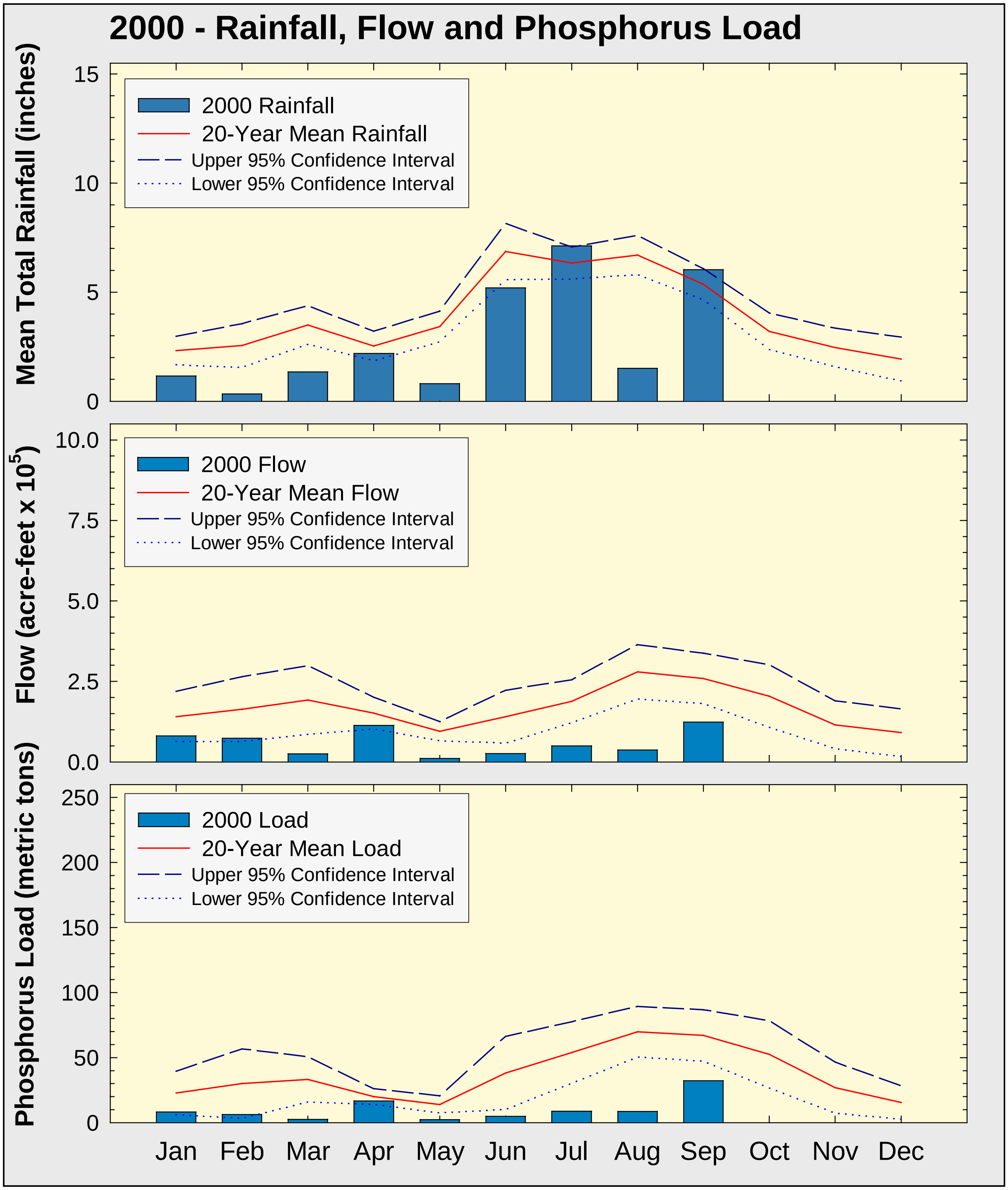

Figure 2. Monthly total phosphorus rainfall, flow and loads for Lake Okeechobee.

Major climatic disturbances (such as El Niño, tropical storms and hurricanes) can alter the seasonal distribution of phosphorus to Lake Okeechobee. During October 1999, scheduled releases of water from Lake Kissimmee combined with Hurricane Irene contributed to the 205 metric tons of phosphorus released to Lake Okeechobee during that month (**Figure 1**).

During the third quarter of 2000, monthly rainfall amounts for July, August and September 2000 were 7.1, 1.5 and 6.0 inches, respectively, across the Lake Okeechobee Basin (**Figure 2**). In 1999, the rainfall amounts were 3.8, 7.8, and 6.9 inches (**Figure 1**) for the corresponding months or approximately 4 inches more than in the third quarter of 2000. The amounts of rainfall recorded in July and September 2000 were within the 95 percent confidence interval for these months, based on the previous 20 years of data (**Figure 2**). The passage of Hurricane Gordon through the extreme eastern Gulf of Mexico in the middle of September contributed to the rainfall amount recorded for that month (**Figure 2**). However, August had rainfall amounts below its expected range (approximately four times lower). In addition, August was the driest since 1987.

Lower average rainfall during the third quarter resulted in lower flows and phosphorus loads to the lake (**Figure 2**). Phosphorus loads to Lake Okeechobee in July, August and September 2000 were 8.9, 8.6 and 32.3 metric tons, respectively, compared to 111, 74.6 and 114 metric tons during the same months in 1999. Rainfall generated by Hurricane Gordon contributed to the higher phosphorus loads observed for September 2000 from S65E structure on the Lower Kissimmee River.

Approximately 40 percent of the phosphorus load during the third quarter of 2000 entered the lake through the S65E and S308 structures. Higher water elevations in the C-44 canal than in Lake Okeechobee resulted in water moving back into the lake through the S308 structure. Approximately 23 percent of the phosphorus load to the lake during this period can be attributed to this backflow. Overall, the phosphorus load for the third quarter of 2000 was approximately four times lower than the 20-year average for the same period (**Figure 2**).

Phosphorus Concentrations for Tributaries and Basins

A phosphorus concentration target for each basin in the Lake Okeechobee Watershed was established under the 1989 Interim Surface Water Improvement and Management (SWIM) Plan. This target was incorporated to ensure a reduction in phosphorus loads to Lake Okeechobee. Under this SWIM Plan, the phosphorus concentration from each basin must either be below 180 parts-per-billion (ppb) or at the 1989-discharge concentration, whichever is less.

The Lower Kissimmee River, S154, Fisheating Creek and Taylor Creek/Nubbin Slough Basins are major contributors of phosphorus load into the lake. Flow-weighted mean concentrations of total phosphorus from these four basins were used to calculate the 12-month moving average concentrations shown in **Figure 3**. These concentrations are compared to the 180-ppb respective target (**Figure 3**).

Since May 1991, the phosphorus concentrations for the Kissimmee River Basin have consistently been at or below the target concentration of 180-ppb (**Figure 3a**). During the first five months of 2000, phosphorus concentrations from the S-154 Basin were about 850 ppb. By September 2000, phosphorus concentrations decreased to 611 ppb (**Figure 3a**).

The moving average phosphorus concentrations in Fisheating Creek have varied above and below the 180-ppb target level. From October 1996 through September 1999, the phosphorus concentrations in the creek were consistently above the target (**Figure 3b**). Since October 1999 through the present reporting period, phosphorus concentrations have remained below the target limit.

A sharp increase in phosphorus concentrations from about 650 ppb to over 870 ppb was observed for the Taylor Creek/ Nubbin Slough Basin beginning in September 1999 (**Figure 3b**). This trend continued in the third quarter of 2000 with phosphorous concentrations in this basin increasing by 90 ppb.

In-Lake Total Phosphorus Concentrations

Lake Okeechobee has a long history of excessive phosphorus loading, which has resulted in major changes in the ecosystem, including an increased frequency of algal blooms, predominantly blue-green algae, and the accumulation of over 30,000 metric tons of phosphorus in the lake sediments. From the early 1970s to the 1990s, total phosphorus concentrations in the lake's water column increased from below 50 ppb to over 100 ppb. Present high total phosphorous concentrations are a function of high external loads and frequent resuspension of phosphorous-rich mud bottom sediments caused by wind. The South Florida Water Management District and other agencies have initiated an aggressive program to reduce external phosphorus loads to the lake and are conducting a feasibility study to determine the ecological, engineering and economic implications of reducing the internal phosphorous load from the lake’s sediments.

In order to assess the seasonal and spatial variations in phosphorus concentrations in the lake resulting from inputs as well as internal cycling, distribution plots of open-water total phosphorus concentrations are presented in **Figures 4a** through **4c**.

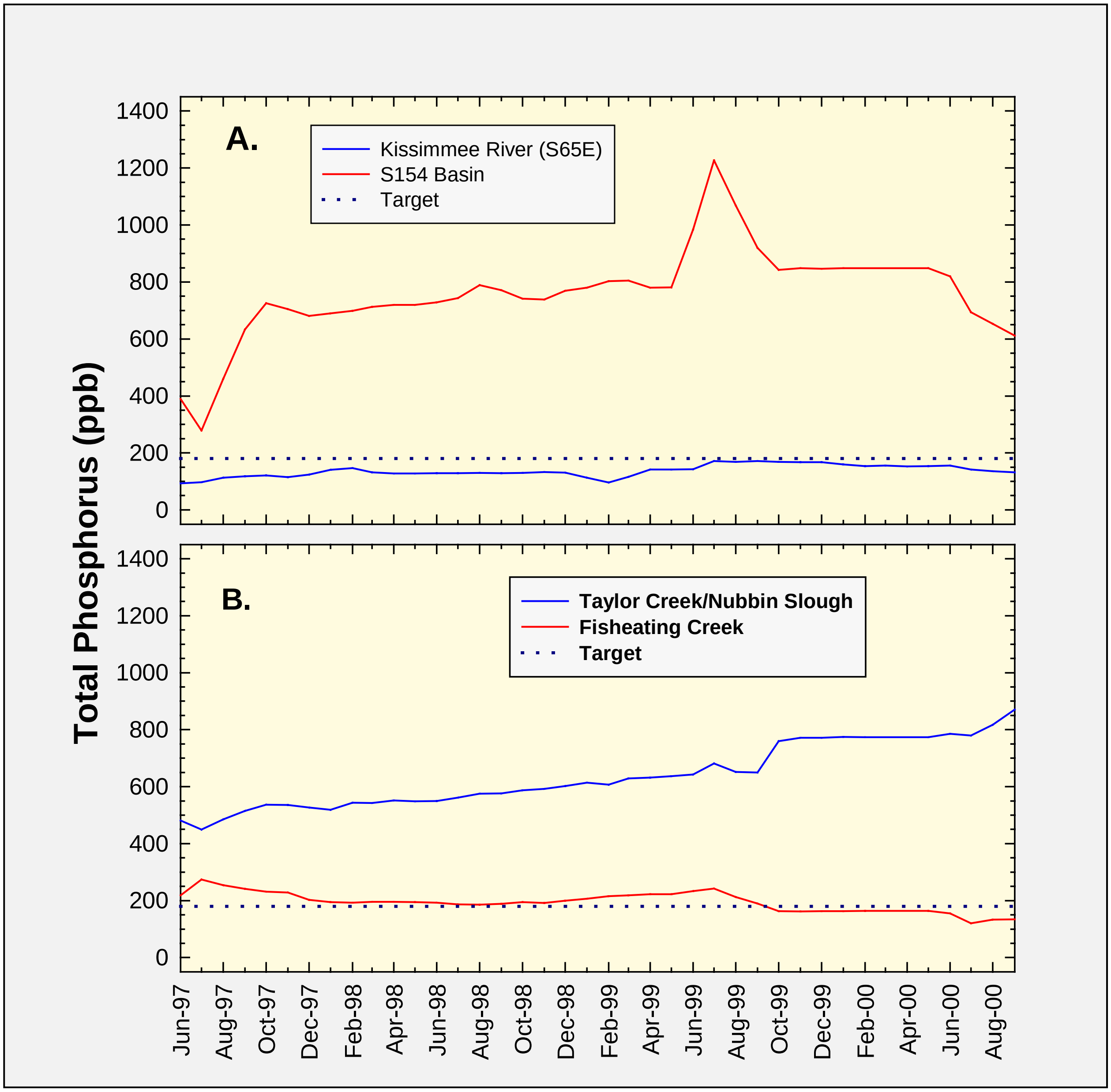

Figure 3. **a.** Twelve-month moving flow-weighted mean total phosphorus concentrations for: a. Kissimmee River and S154 Basins and **b.** Taylor Creek/ Nubbin Slough and Fisheating Creek. The four basins/tributaries drain into Lake Okeechobee.

Boat problems during the July monitoring event resulted in the collection of an insufficient amount of samples to generate contour plots for total phosphorus. Therefore, only plots for August and September will be presented in this report.

The arithmetic mean concentration of total phosphorus in Lake Okeechobee was 67 and 59 ppb for August and September, respectively. By comparison, total phosphorous concentrations in

1999 for the same months were 68 and 96 ppb, respectively. In addition, total phosphorus concentrations in the lake were lower than those measured for the second quarter of 2000.

The contour plot shown in **Figure 4a** depicts total phosphorus concentrations in Lake Okeechobee for August 2000. Approximately 66 percent of the total phosphorus concentrations measured for this month was less than 100 ppb (**Figure 4a**). Total phosphorus concentrations greater than 100 ppb extended from the central portion of the lake to its eastern shore. The higher phosphorus concentrations in the eastern portion of the lake may be associated with the backflow of water to the lake from the C-44 canal through the S308 structure.

By the first half of September 2000, total phosphorus concentrations in the lake averaged 61 ppb. Approximately 85 percent of phosphorus concentrations measured during the first half of September was below 100 ppb (**Figure 4b**). Fisheating Bay, located in the western portion of Lake Okeechobee, as well as the near shore areas in the southwestern portion of the lake had total phosphorus concentrations lower than 40 ppb.

A slight decrease in total phosphorus was observed in the second half of September with the average concentration reaching 57 ppb. Approximately 90 percent of the lake had total phosphorus concentrations less than 100 ppb (**Figure 4c**). Higher total phosphorus concentrations occurred near the mouth of the Kissimmee River (in the northwest section of the lake) and near the S308 structure, which is located in the eastern section of the lake (**Figure 4c**). The effects from Hurricane Gordon may have contributed to the phosphorus concentrations near the Kissimmee River mouth. Overall, the declining phosphorus concentrations measured during August and September 2000 likely reflect the combined influence of two phenomena. First, there were low phosphorus inputs from the watershed because of reduced rainfall. Second, the lowered lake levels during the second quarter of 2000 resulted in more light reaching the lake bottom and a substantial increase in submerged aquatic vegetation, which take up phosphorus from the water column and sediments for growth.

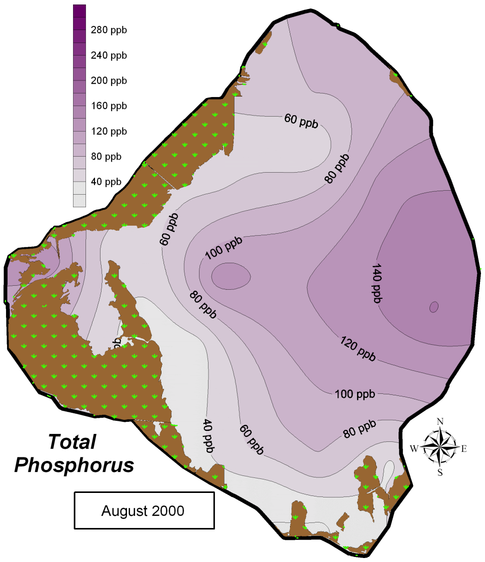

Figure 4a. Total phosphorus concentrations for open water monitoring sites in Lake Okeechobee, August 2000.

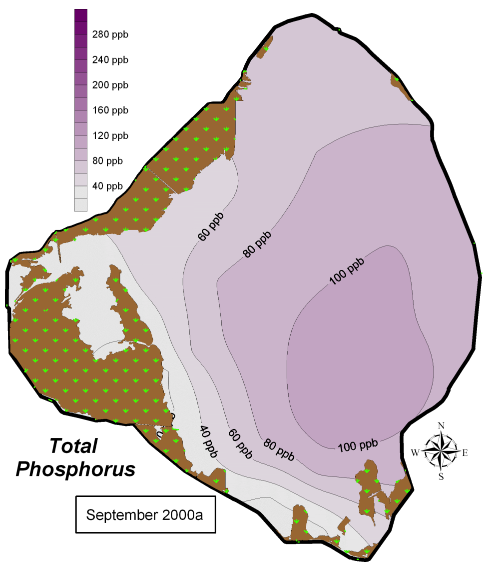

Figure 4b. Total phosphorus concentrations for open water monitoring sites in Lake Okeechobee, in the first half of September 2000.

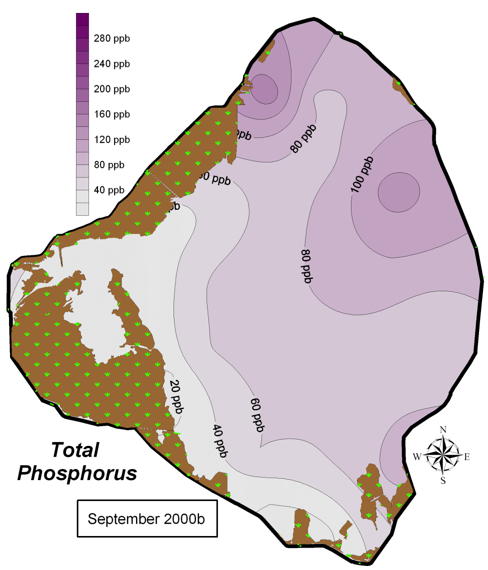

Figure 4c. Total phosphorus concentrations for open water monitoring sites in Lake Okeechobee, in the second half of September 2000.

Light Penetration

Secchi depth is a measure of how deep light penetrates the water column. The Secchi depth is measured by lowering a 30-cm diameter white disk through the water column until it is just visible. At the Secchi depth, solar light penetrating the water is reflected off the surface of the disk in a quantity sufficient to come back through the water and reach the observer's eye. The amount and composition of suspended material along with the presence of dissolved colored substances in the water column affect Secchi depth. When either of these two variables is high, light will not penetrate deeply into the water column (i.e., Secchi depth decreases).

The transmission of light in lakes and other bodies of water is extremely important because solar radiation is the primary source of energy for photosynthetic organisms such as algae and aquatic plants. An increase in light penetration can cause increased photosynthetic activity, resulting in higher primary productivity if nutrients are not limiting.

As a result of boat problems, insufficient samples were collected during the July and August monitoring events to generate contour plots. Secchi depth measurements were only performed for the two monitoring events in September. During these two monitoring events, visibility in the lake improved with the average Secchi depth reaching 0.5 meters in the first half of the month and 0.7 meters in the second half (**Figures 5a** and **5b**).

Light penetration in Lake Okeechobee extended down to a maximum depth of 0.7 meters during the first half of September 2000 (**Figure 5a**). Approximately 65 percent of the lake had light penetrating to a depth of 0.4 meters.

By the second half of September, light penetration in Lake Okeechobee extended down to a maximum depth of 1.6 meters. Approximately 80 percent of the lake had Secchi depths up to 0.4 meters. The southwestern region of the lake had the deepest light penetration (**Figure 5b**).

An inverse relationship between Secchi depth and total phosphorous was also observed during the third quarter of 2000. In other words, total phosphorus concentrations decline with increasing Secchi depth. Biological uptake of phosphorous in the shallower near-shore areas may play a more important role in controlling phosphorous concentrations.. Average Secchi depths measured during the third quarter of 2000 improved slightly (approximately 0.2 meters) compared to the corresponding period in 1999.

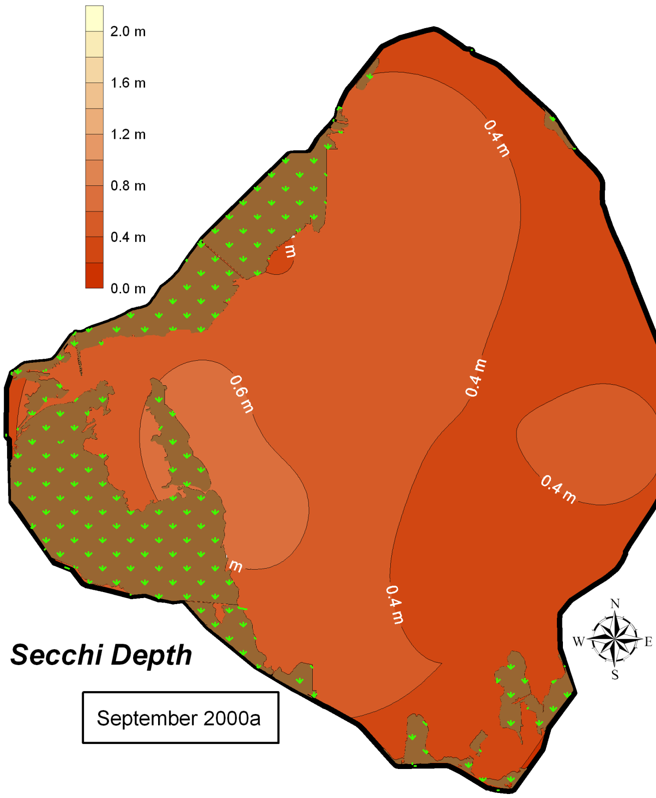

Figure 5a. Depth of light penetration (Secchi depth) measured in meters for Lake Okeechobee, first half of September 2000.

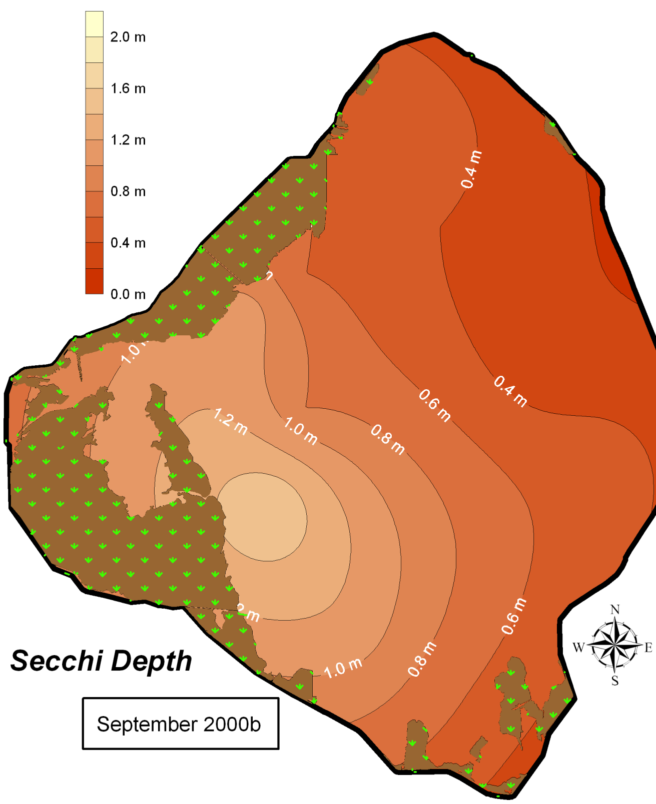

Figure 5b. Depth of light penetration (Secchi depth) measured in meters for Lake Okeechobee, second half of September 2000.

Chlorophyll *a* Concentrations

Chlorophyll *a* is a green pigment present in terrestrial and aquatic plants, including algae. This pigment functions to absorb visible light. The energy associated with the absorbed light is used to drive photosynthesis. Chlorophyll *a* concentrations are an indicator of the amount of living plant (or algal) material in a water body.

Naturally occurring algal populations present in Lake Okeechobee will form blooms under certain weather and water quality conditions.

Algal blooms are dense concentrations of algae over large areas of a water body. Blooms might be composed of undesirable species that are harmful to other aquatic life, possibly form nuisance scums on the water surface and create taste and odor in the drinking water supply. If algal populations are large enough, they can also reduce oxygen levels in the water column during algal die-off resulting in invertebrate and fish kills.

Severe bloom conditions generally occur when chlorophyll *a* concentrations exceed 60 ppb. Concentrations between 40 and 60 ppb are indicative of moderate bloom conditions. The occurrence and effects of these bloom conditions on the lake depend on a variety of factors. Persistence of bloom conditions over large areas may indicate increased nutrient concentrations.

Boat problems during the July monitoring event resulted in an insufficient amount of samples collected to generate contour plots for chlorophyll *a*. Therefore, only contour plots for August and September will be presented in this report.

Lake-wide chlorophyll *a* distributions for one monitoring event in August and two events in September 2000 are presented in **Figures 6a** through **6c**. During these three monitoring events, chlorophyll *a* levels in Lake Okeechobee averaged 16.0 ppb in August, 32.3 ppb in the first half of September and 15.8 ppb in the second half of September. The average chlorophyll *a* level in the third quarter of 1999 was approximately 1.5 times higher than for the same period in 2000.

A moderate bloom condition was observed in August near the littoral shelf located along the northwestern shores of Lake Okeechobee (**Figure 6a**). This bloom covered approximately 2.5 percent of the lake's surface water. More than 95 percent of the lake had chlorophyll *a* concentrations below 40 ppb during August.

Bloom conditions extended over approximately 15 percent of Lake Okeechobee during the first half of September 2000 (**Figure 6b**). This region stretched from the littoral shelf (located on the western shore of the lake) toward the northern tip of the lake.

Moderate bloom conditions covered approximately 18 percent of the lake. The remaining 67 percent of the lake had chlorophyll *a* concentrations lower than 40 ppb (**Figure 6b**).

By the second half of September, chlorophyll *a* concentrations throughout Lake Okeechobee decreased. A moderate bloom condition covered only 6 percent of the lake. In addition, 67 percent of the lake had chlorophyll *a* concentrations lower than 20 ppb (**Figures 6c**). These lower chlorophyll *a* concentrations occurred in the southern portion of the lake where lower total phosphorus levels and greater Secchi depths were also observed (**Figures 4c**, **5c** and **6c**).

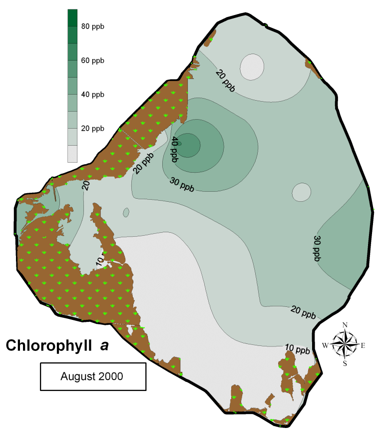

Figure 6a. Chlorophyll *a* levels at open water monitoring sites in Lake Okeechobee, August 2000

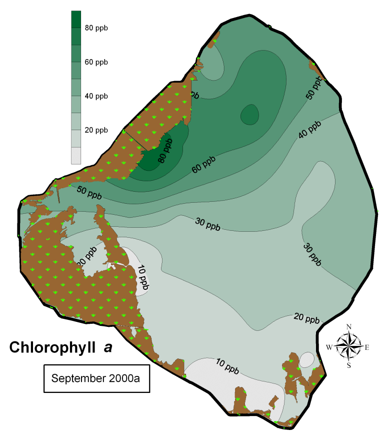

Figure 6b. Chlorophyll *a* levels at open water monitoring sites in Lake Okeechobee, first half of September 2000

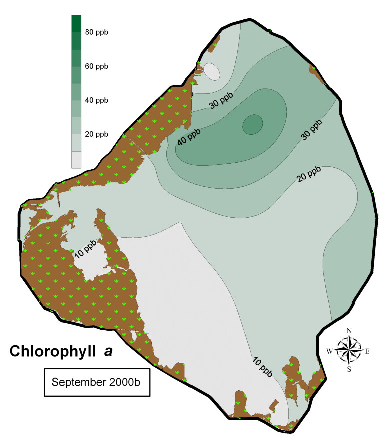

Figure 6c. Chlorophyll *a* levels at open water monitoring sites in Lake Okeechobee, second half of September 2000

EVERGLADES AGRICULTURAL AREA

SUMMARY

MAP

Phosphorus Loading Trends

The Everglades Best Management Practices (BMP) Program (Rule 40-E, 63, Florida Administrative Code) for the Everglades Agricultural Area (EAA) requires that the EAA basin achieve a 25 percent reduction in total phosphorus (TP) load discharged to the Everglades. The reduction is determined by comparing phosphorus discharges at the end of each 12-month water year period (May 1 through April 30) with the pre-BMP base period of October 1, 1978, through September 30, 1988. The first full year of BMP implementation was water year 1996.

The third quarter of 2000 produced average rainfall conditions for the EAA basin. Rainfall received during July (8.0 inches) and September (6.74 inches) was higher than the historical averages, while August (4.57) was drier than average. Total rainfall for the quarter was 19.3 inches, which approximated the amount received during the same quarter in 1999.

The release of water from Lake Okeechobee in April and May to the EAA basin, as part of the Shared Adversity, resulted in a low lake level. The Lake remained at low levels due to relatively little rainfall occurring in the contributing watersheds. Therefore, relatively minor water supply releases were made to the EAA basin during the third quarter, which caused only minor effects on the EAA basin with respect to water quality.

Approximately 20,000 acre-feet of lake water were released through S351 and S354, combined, to the EAA canals. In comparison, 205,000 acre-feet of water were discharged from the EAA through pump stations S6, S7 and S8 to the Water Conservation Areas (WCAs). As a result of rainfall received in the EAA basin, the District conducted flood control pumping during most of the third quarter. The total phosphorous loads for July and September were similar, and the monthly loads during the third quarter varied with the rainfall previously described (**Figure 7**). The total load for the quarter was approximately 60 percent of the load for the same quarter in the previous year.

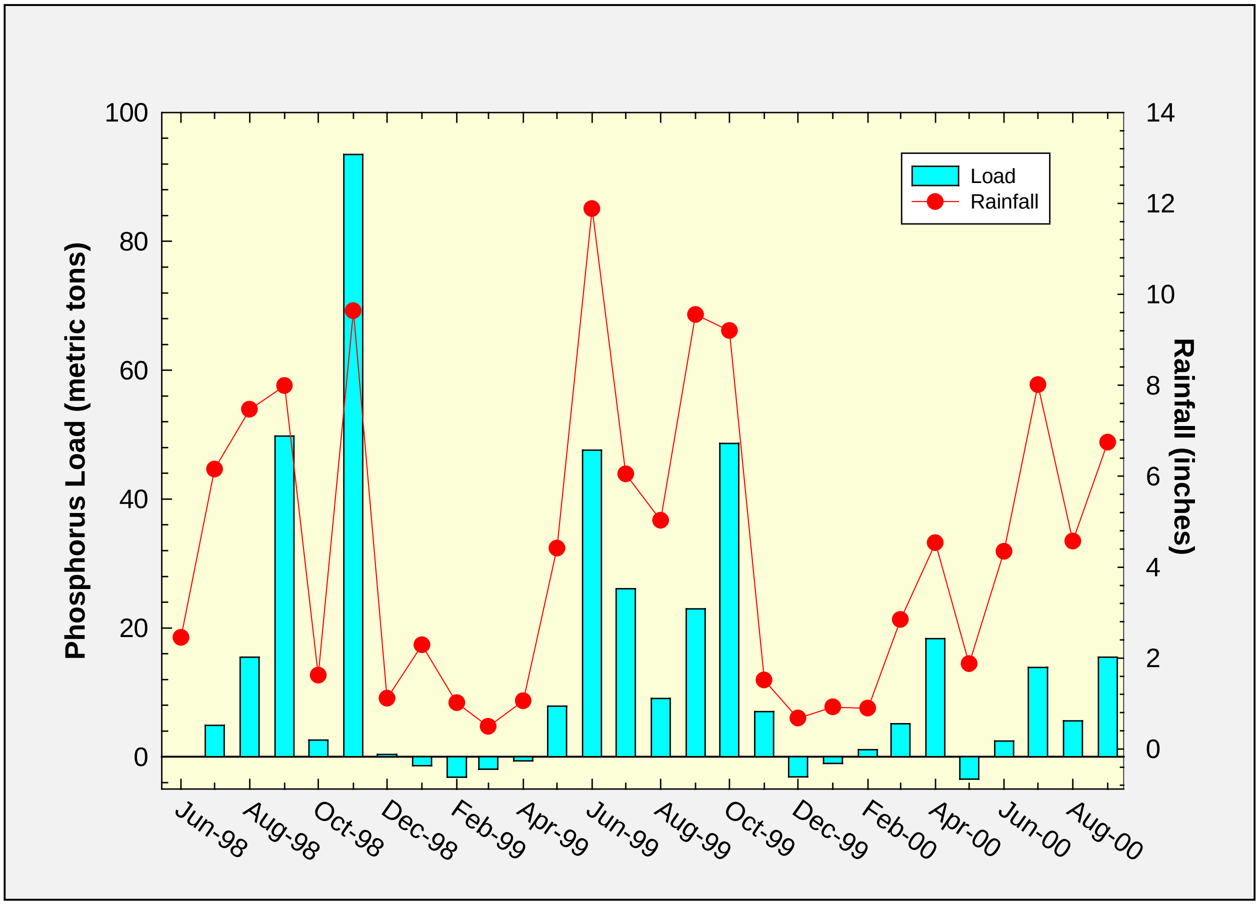

Figure 7. Monthly phosphorus loads calculated for the EAA Basin and monthly rainfall for the EAA.

Total phosphorus loads and flows measured at District pump stations S5A, S6, S7, S150, and S8 (see map), which convey a majority of the water from the EAA to the WCAs, are presented in **Figure 8.** The flow-weighted mean total phosphorus concentrations released from these stations into the WCAs are presented in **Figure 9**.

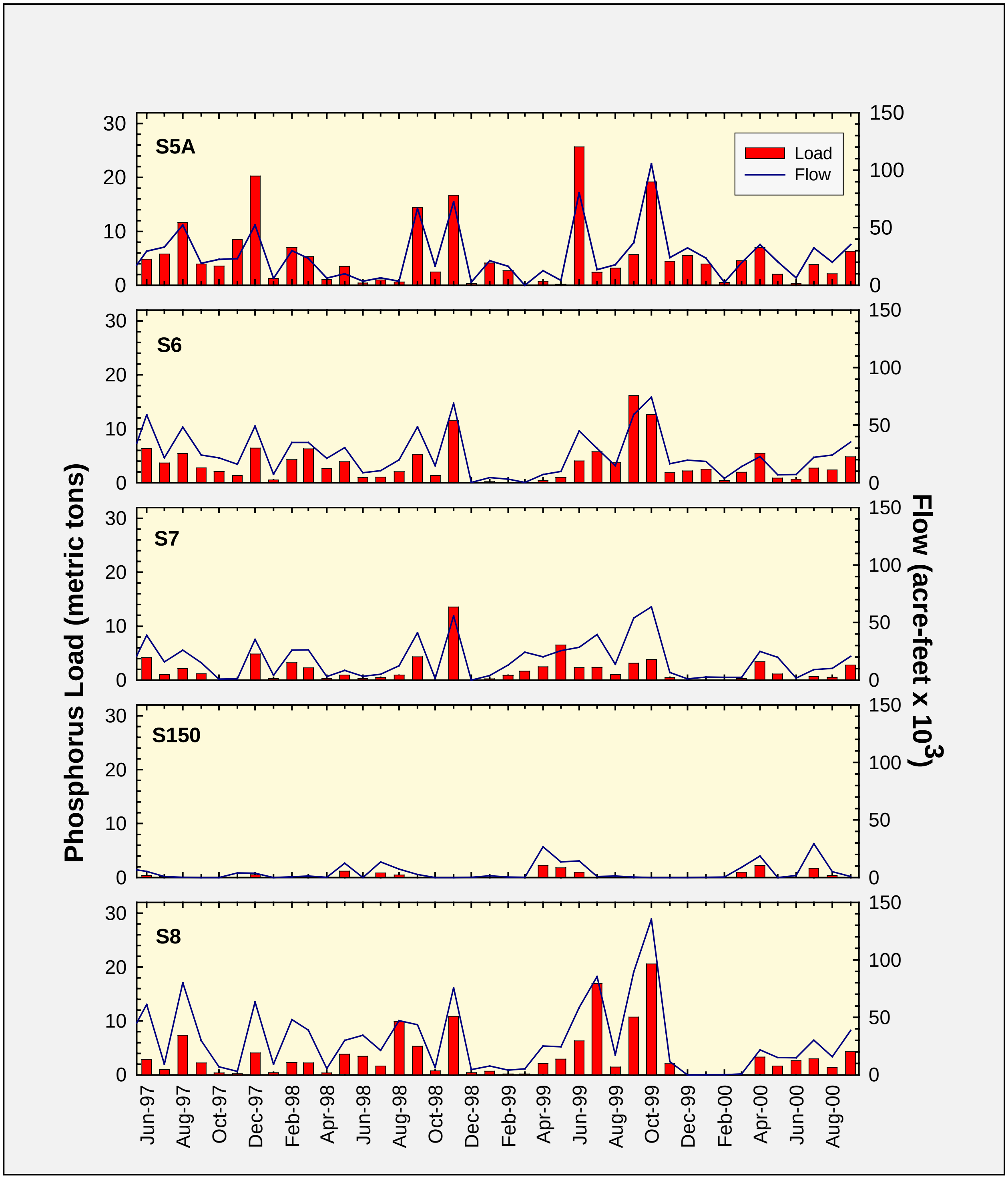

Figure 8. Monthly flows and calculated phosphorus loads at major EAA pump stations.

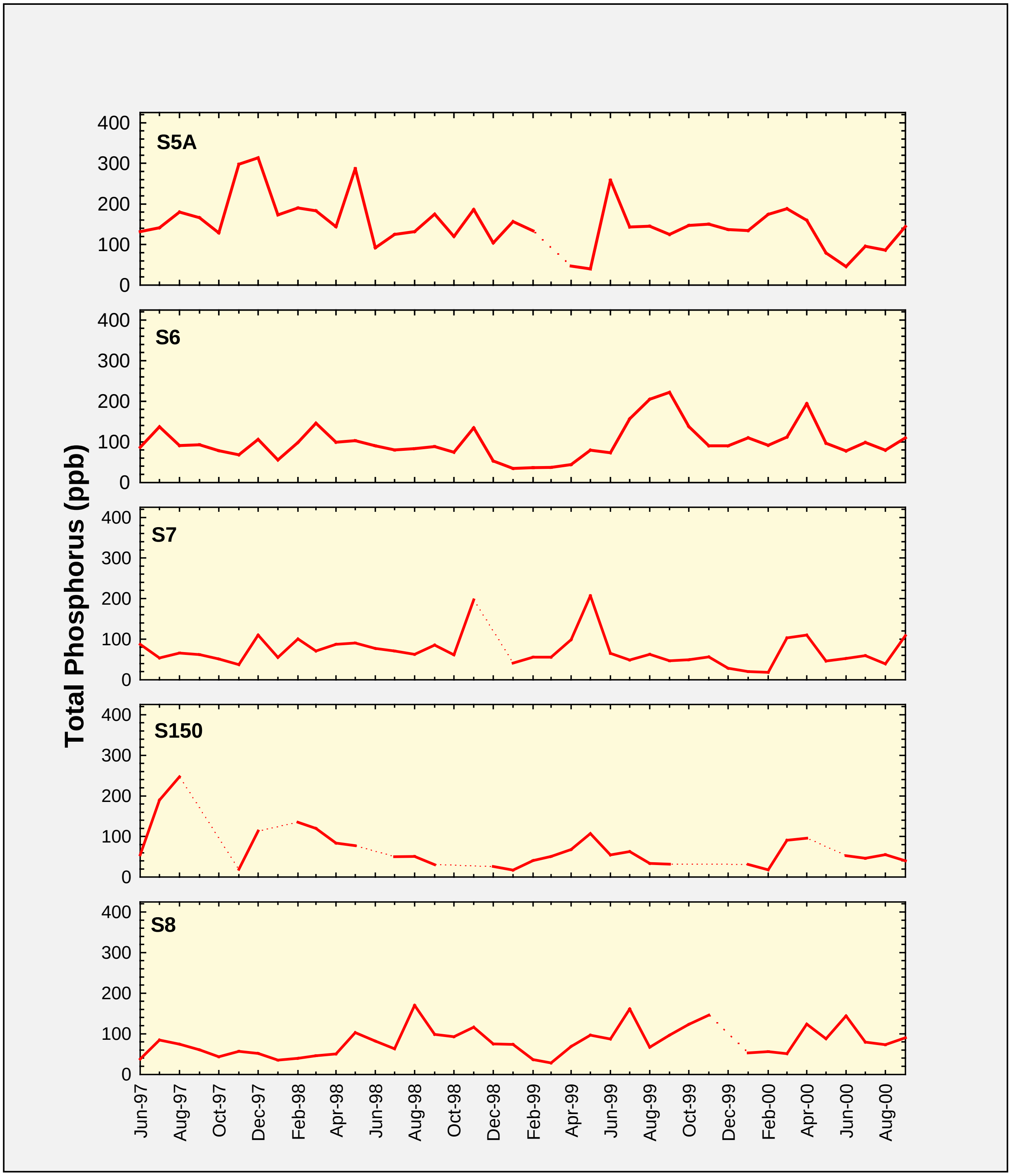

Figure 9. Monthly flow-weighted mean total phosphorus concentrations at major EAA pump stations (dashed lines indicate periods of zero flow).

A summary of monthly flows measured at each structure during the third quarter of 2000 is presented in **Table 2**. In addition, total phosphorus loads for each structure during the reporting period are summarized in **Table 3**. Flow-weighted mean total phosphorus concentrations determined at the four pump stations during the second quarter of 2000 are presented in **Table 4**.

Table 2. EAA Pump Station Flows (k-acft)

	Jul-00	Aug-00	Sep-00
S5	32.3	20.1	35.3
S6	22.1	24.0	35.3
S7	9.0	10.1	20.7
S150	29.4	5.1	0.8
S8	30.2	15.7	38.7
Sum	**123.0**	**75.0**	**130.8**

Table 3. EAA Pump Station TP Loads (metric tons/month)

	Jul-00	Aug-00	Sep-00
S5	3.8	2.1	6.3
S6	2.7	2.4	4.8
S7	0.7	0.5	2.8
S150	1.7	0.3	0.0
S8	3.0	1.4	4.3
Sum	**11.8**	**6.7**	**18.2**

Table 4. EAA Pump Station Flow-weighted Mean TP Concentrations (ppb)

	Jul-00	Aug-00	Sep-00
S5	96	86	144
S6	99	79	110
S7	59	39	109
S150	46	55	40
S8	79	73	90

STORMWATER TREATMENT AREAS

STORMWATER TREATMENT AREA 1 WEST

SUMMARY

MAP

Background

Stormwater Treatment Area 1 West (STA-1W) encompasses the four treatment cells of the Everglades Nutrient Removal Project (ENR) plus the newly constructed treatment Cell 5 creating a total effective treatment area of 6,870 acres. The permit for the ENR expired at the end of April 1999. The STA-1W permit went into effect May 11, 1999. Cell 5 passed the start-up phase of operation for both phosphorus and mercury during the week of January 17, 2000.

In accordance with construction plans, the inflows to STA-1W were diverted July 12, 1999, from pump station G-250 to inflow structure G-302, a component of the new Inflow and Distribution Works for STAs-1W and 1E. As a result of the diversion, pump station S5A became the inflow monitoring station for STA-1W. The outflow site (G251) from the ENR permit remains the same for the STA1W permit, a new outflow pump station,G310, which began operation on July 5, 2000. G310 flow discharges predominantly from Cell 5.

Phosphorus Loads and Concentrations

Total phosphorus loads input to STA-1W were reduced by 78 percent in July, 78 percent in August and 88 percent in September 2000 (**Figure 10a**). During the third quarter of 2000, 12 etric tons of total phosphorus went through S5A compared with 1 metric ton discharged from the outflow of STA-1W,G251 and 1 metric ton through G310 (**Figure 10b**). **Figure 10a** will only display monthly load reductions starting in May 1999 when the STA-1W permit went into effect. The 12-month reduction and the target reduction of 75 percent will no longer be displayed because they are not required in the STA-1W permit.

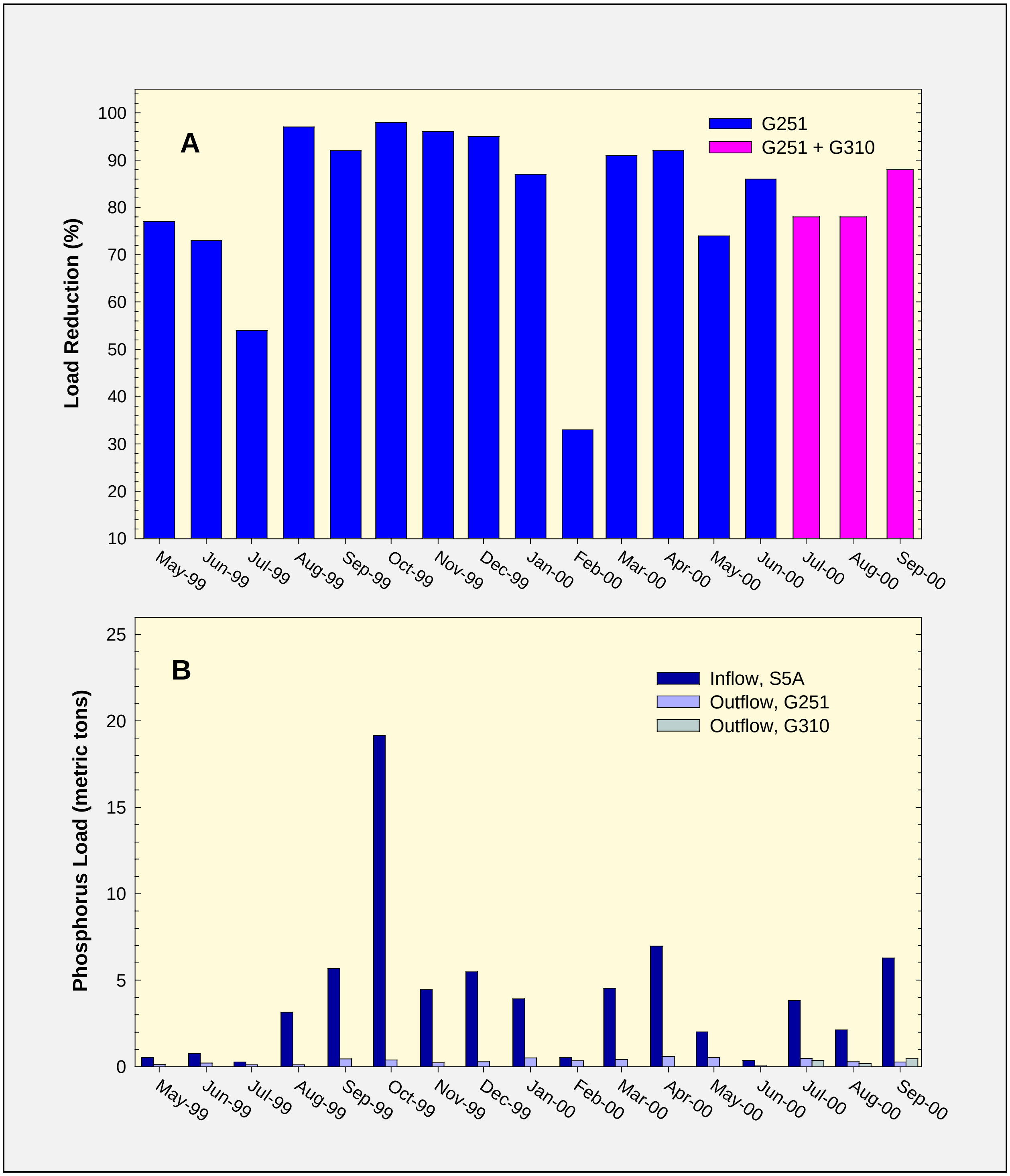

Figure 10. **a.** Monthly percent reduction of total phosphorus in STA-1W.
b. Monthly total phosphorus loads at inflow and outflow sites of STA-1W.

The monthly average flow-weighted mean total phosphorus inflow concentrations for S5A were 96, 86 and 144 ppb in July, August and September, respectively (**Figure 11**). The flow-weighted mean concentrations in the outflows were 27, 22, and 27 ppb in G251, 65 and 28, and 53 ppb in G310 for the same three months.

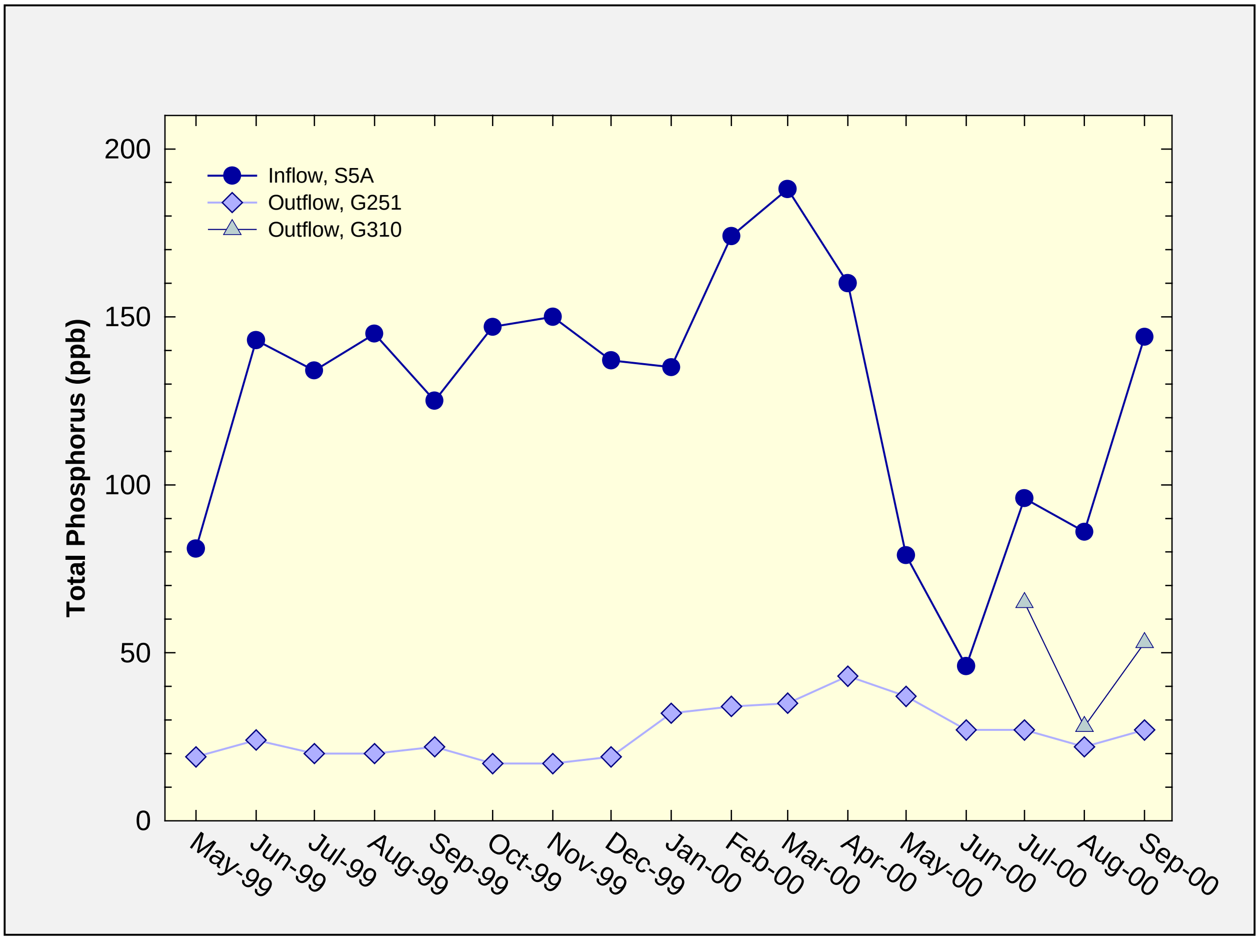

Figure 11. Monthly flow-weighted mean total phosphorus concentrations at inflow and outflow sites of STA-1W.

Mercury Monitoring

The STA permits require the District to collect unfiltered water samples quarterly at inflows and outflows for analysis of total mercury (THg) and methylmercury (MeHg). The permits also require the District to collect between 100 and 250 mosquitofish *(Gambusia holbrooki*) semiannually and 20 largemouth bass *(Micropterus salmoide*s) annually from the inflow, interior marshes and outflows for mercury analysis. Individual mosquitofish are pooled to form composite samples for each location. In 2000, sunfish *(Lepomis spp.)* were added to this monitoring program to better evaluate mercury exposure to fish-eating birds. Monitoring mercury concentrations in aquatic animals provides several advantages. First, methylmercury occurs at much greater concentrations in biota (animal and plant life) relative to surrounding water, making chemical analysis more accurate and precise. Although detection levels of part per trillion (ppt or ng/L) have been achieved for total mercury and methylmercury in water, uncertainty boundaries can become large when ambient concentrations are very low, as is often the case in the Everglades. Second, organisms integrate exposure to mercury over space and time. Since mosquitofish are short-lived, they can be used to monitor short-term changes in environmental concentrations of mercury through time. Largemouth bass and sunfish are long-lived species and represent average conditions that occurred over previous years. Finally, the mercury concentration in biota is a true measure of methylmercury bioavailability and is therefore a better indicator of possible mercury exposure to fish-eating wildlife than the aqueous concentration of mercury in surface water.

Mercury Levels STA-1W

Routine monitoring of mercury concentrations at STA-1W began February 16, 2000. Surface water samples for the third quarter of 2000 were collected August 22. At that time, construction of the second outflow pump, G310, had been completed. Total mercury concentration was 2.6 ng/L at the inflow and 2.3 ng/L at the two outflows (G251 and G310). While concentrations of total mercury were slightly elevated compared to the first two quarters (**Figure 12a**), they were within the typical range previously measured in this area when it was operated as the Everglades Nutrient Removal Project. Total mercury concentrations were lower at the outflows compared to the inflow and were below Florida's Class III Water Quality Standard of 12 ng/L. Methylmercury concentration was 0.46 ng/L at the inflow and 0.61 (G251) and 0.12 (G310) ng/L at the two outflows (**Figure 12b**). Methylmercury concentration at the G251 outflow was greater than the concentration observed at the inflow and was at the extreme range of levels previously measured during operation of the ENR project. While the level of methylmercury at G251 warrants continued scrutiny, it does not represent an anomalously high value when compared to concentrations observed at other locations in south Florida, including other STAs.

Results from the annual collections of largemouth bass and sunfish are reported in the *2001 Everglades Consolidated Report* (SFWMD, 2001). Results from the first semiannual collection of mosquitofish (**Figure 13**), were first reported in the October 2000 Environmental Conditions Update Report. As previously stated, concentrations of mercury in fish tissues were well below guidance levels suggested by both the U.S. Fish and Wildlife Service (USFWS; 100 ng/g) and the U.S. Environmental Protection Agency (U.S. EPA; 77 ng/g) for the protection of fish-eating avian and mammalian wildlife.

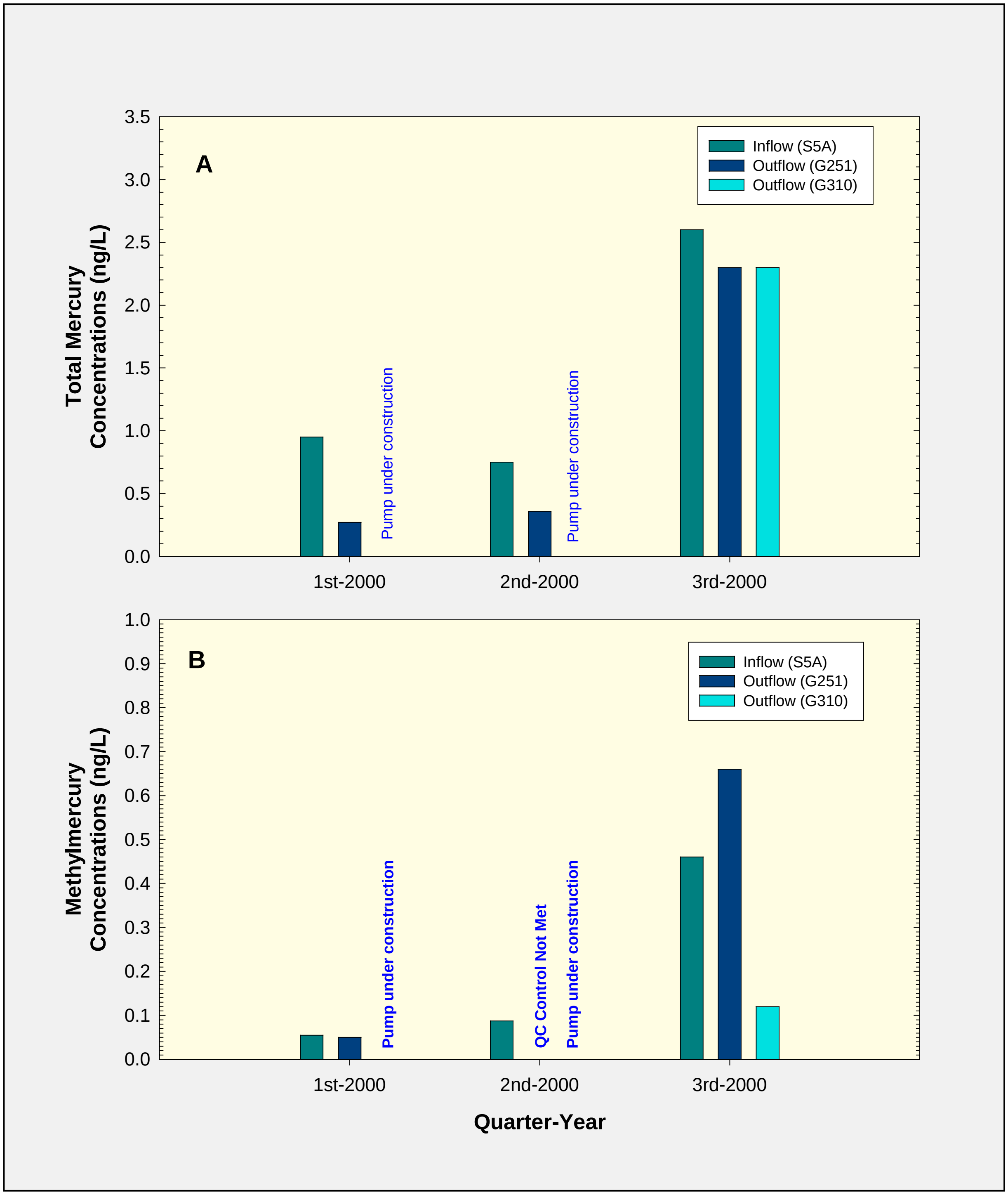

Figure 12. **a.** Quarterly surface water total mercury concentrations at inflow and outflow sites of STA-1W. **b**. Quarterly surface water methylmercury concentrations at infow and outflow sites of STA-1W.

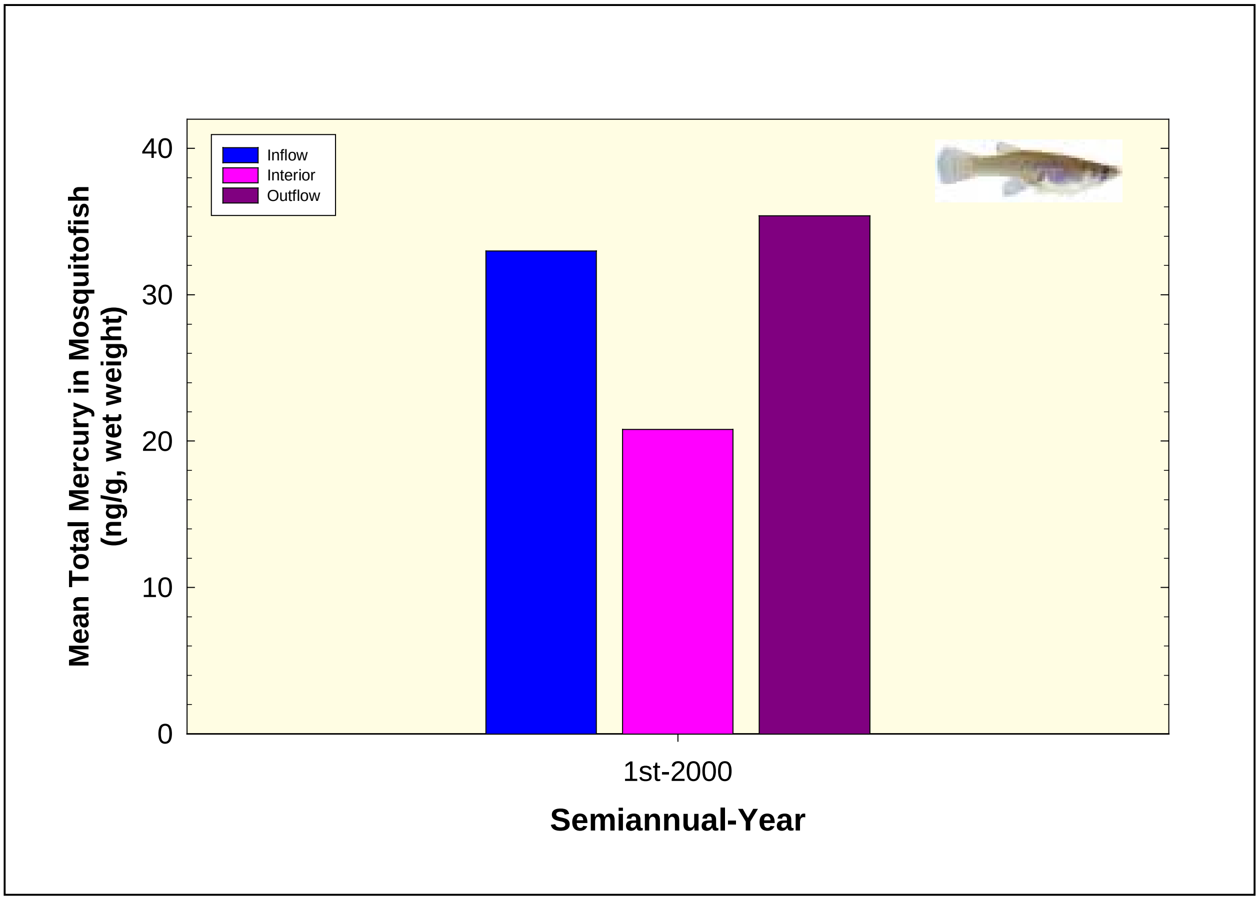

Figure 13. Mean total mercury concentrations in mosquitofish collected at the inflow, interior and outflow of STA-1W.

STORMWATER TREATMENT AREA 5

SUMMARY

MAP

Background

Stormwater Treatment Area 5 (STA-5), began flow-through operation on July 7, 2000. STA-5 has an approximate treatment area of 4,118 acres, which was previously agricultural cropland. STA-5 will receive untreated runoff from the C-139 Basin via the L3 canal, and discharge treated water to the Miami Canal.

Phosphorus Concentrations

For the third quarter of 2000, the flow-weighted mean total phosphorus concentrations at the four inflow sites (G342A-D) averaged 191 ppb for July, 185 ppb for August and 227 for September. At the four outflow sites (G344A-D) the flow-weighted mean averaged 95 ppb for July, 130 ppb for August and 124 for September.

Phosphorus Loads

The total phosphorus load reduction for the third quarter of 2000 for STA-5 was 50 percent for July, 58 percent for August, and 63 percent for September (**Figure 14a**). The total phosphorus load entering STA5 was 1.4 metric tons for July, 2.8 metric tons for August, and 4.7 metric tons for September. The total phosphorus load leaving STA-5 was 0.7 metric tons for July, 1.2 metric tons for August, and 1.7 metric tons for September (**Figure 14b**).

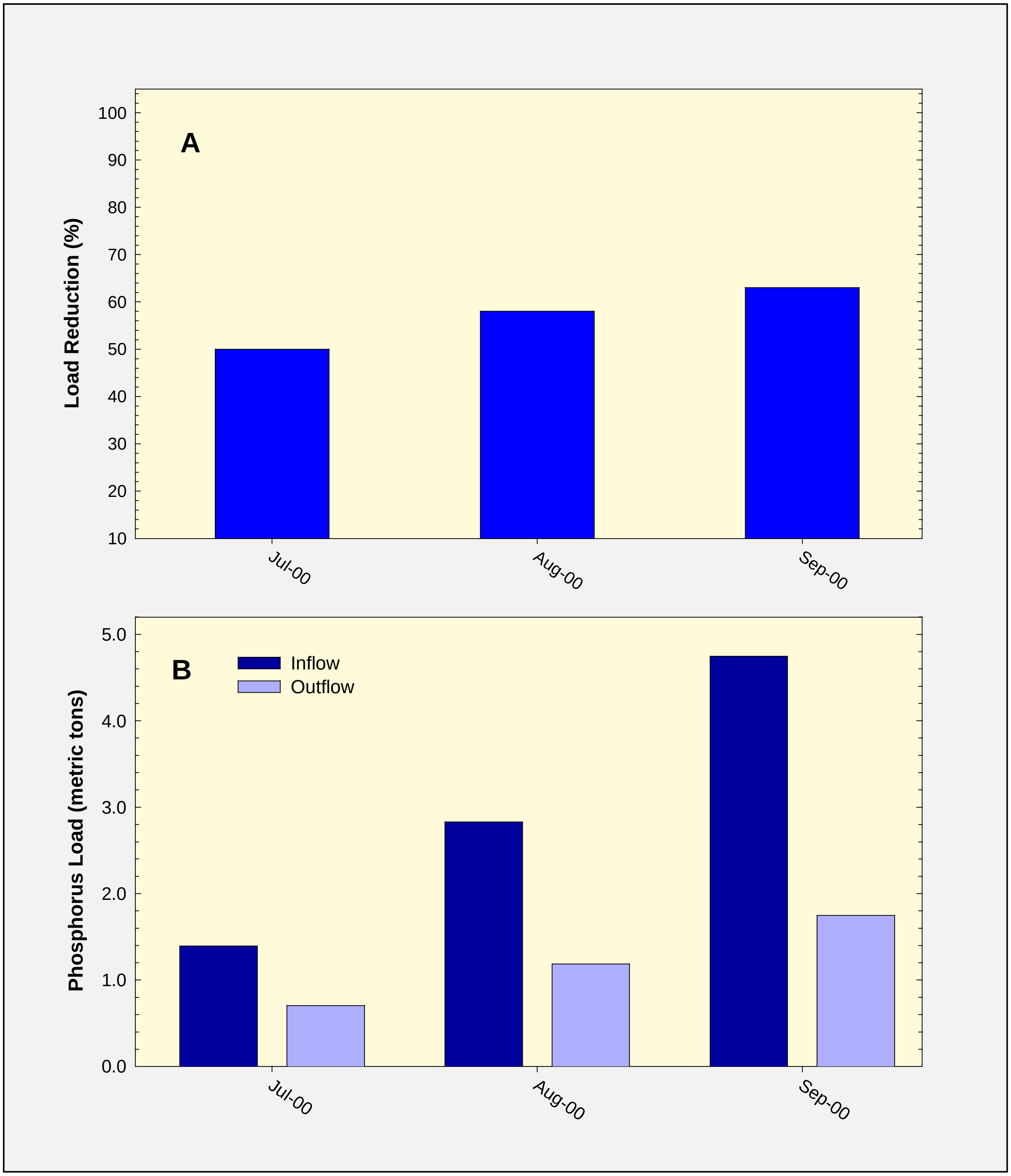

Figure 14. **a.** Monthly percent reduction of total phosphorus load by STA-5.
b. Monthly total phosphorus loads at inflow and outflow sites of STA-5.

Mercury Levels STA-5

Routine monitoring of mercury levels at STA-5 began during the first quarter of 2000. Surface water samples for the third quarter of 2000 were collected September 27. At that time, the mean total mercury concentration was 2.8 ±0.4 ng/L at the four inflows (mean ± standard deviation; *standard deviation measures the variability or dispersion of data around the mean. A small standard deviation implies that the data are clustered around the mean. For a normal distribution, about 95 percent of the observations should lie within two standard deviations of the mean*), and 1.9 ±0.3 ng/L at the four outflows (**Figure 15a**). Methylmercury concentration at the inflows and outflows were 0.3 ±0.2 and 0.2 ±0.2 ng/L, respectively (**Figure 15b**). Both total mercury and methylmercury were at lower concentration in the outflows compared to the inflows. Moreover, total mercury concentration remained below the Class III Water Quality Standard of 12 ng/L.

The first semiannual collection of mosquitofish occurred March 22, 2000. It should be noted that routine discharge had not begun at the time these samples were collected. Average tissue mercury concentration was 38 ±0.75 ng/g (on a wet weight basis) in mosquitofish collected near the inflows, 67 ±19 ng/g in mosquitofish from interior marshes and, 61 ±24 ng/g in mosquitofish from the discharge canal near the outflows (**Figure 16**). Concentration of mercury in these fishes were below guidance levels suggested by both the U.S. Fish and Wildlife Service (USFWS; 100 ng/g) and the U.S. Environmental Protection Agency (U.S. EPA; 77 ng/g) for the protection of fish eating avian and mammalian wildlife.

For more information about STA mercury monitoring permit requirements, please click here.

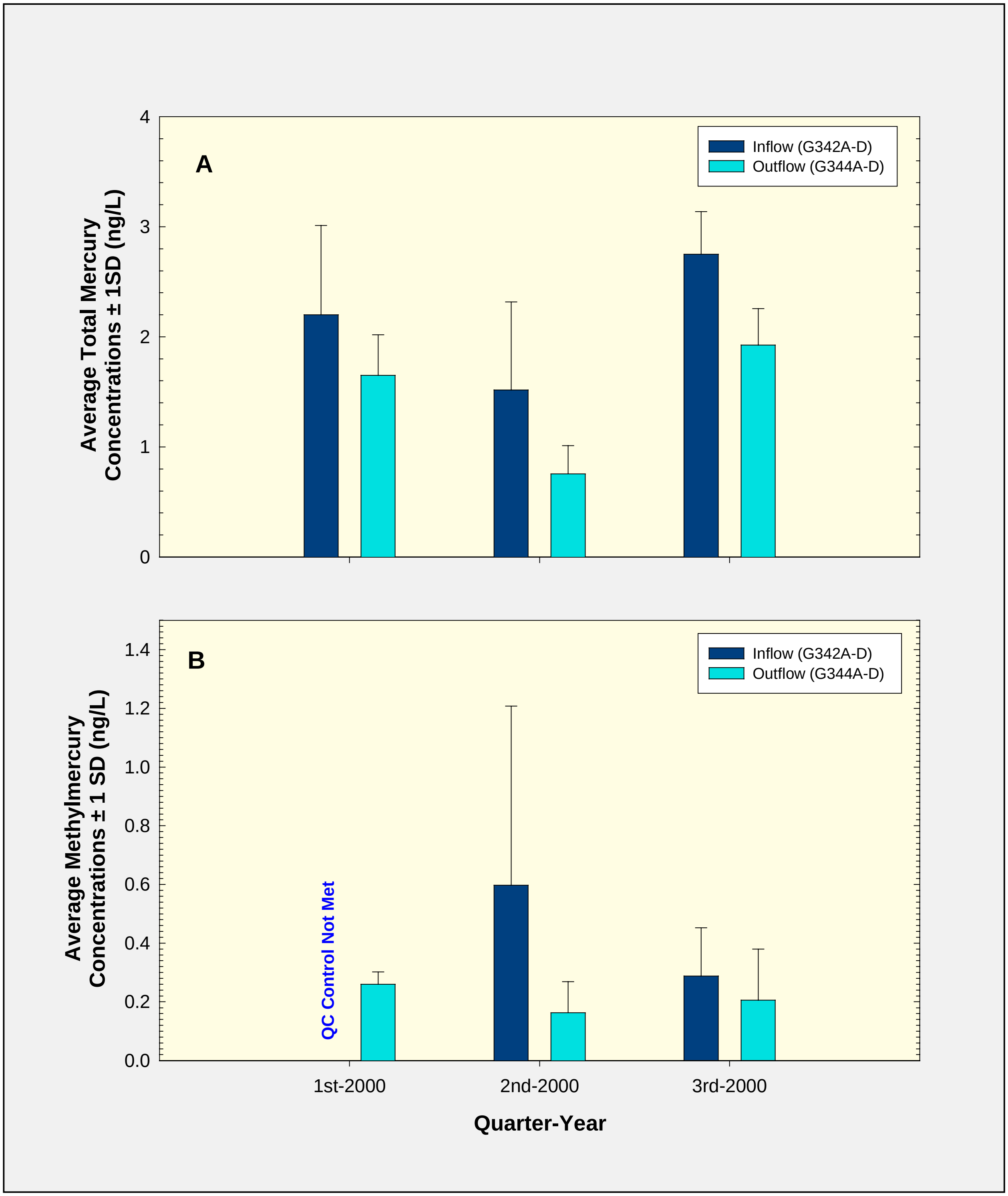

Figure 15. **a.** Quarterly surface water total mercury concentrations at inflow and outflow sites of STA-5. **b.** Quarterly surface water methylmercury concentrations at infow and outflow sites of STA-5. (Error bars depict standard deviation around the mean.)

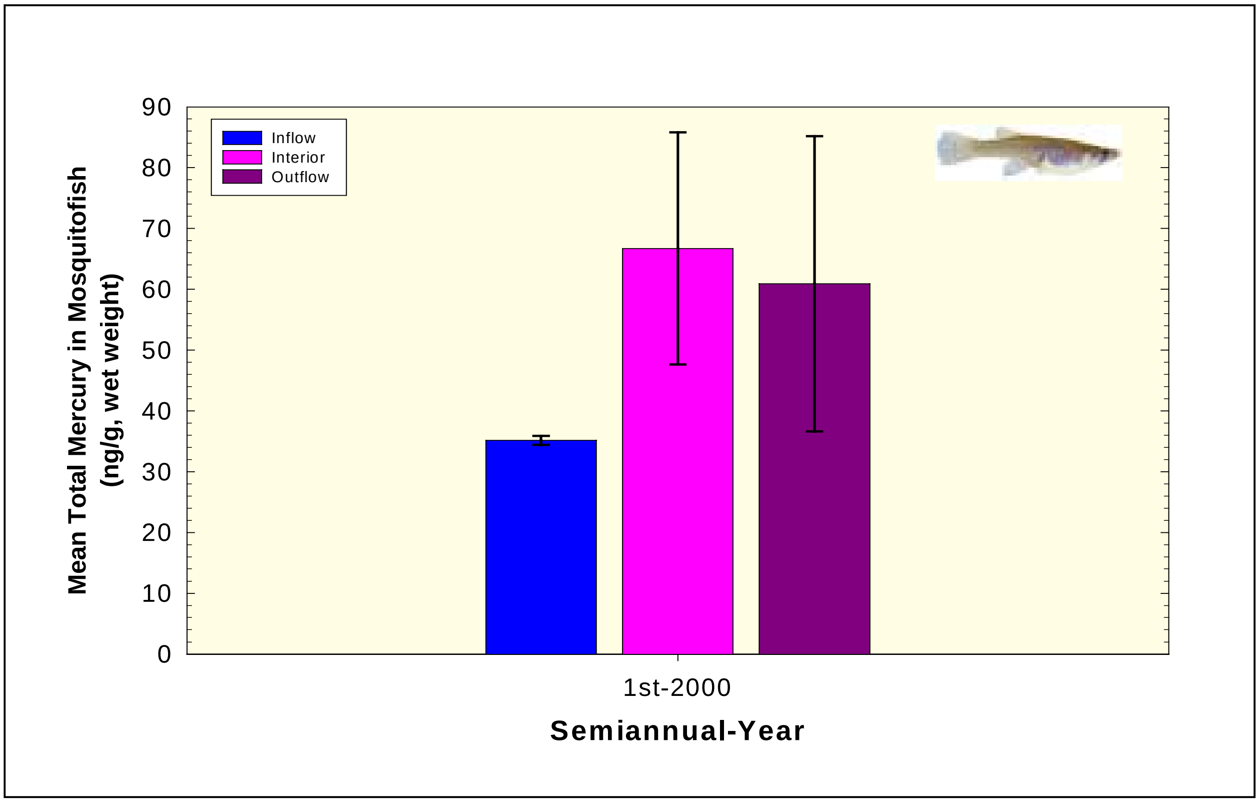

Figure 16. Mean total mercury concentrations in mosquitofish collected at the inflow, Interior and outflow of STA-5. (Error bars depict standard deviation around the mean.)

STORMWATER TREATMENT AREA 6

SUMMARY

MAP

Background

Stormwater Treatment Area 6 (STA-6), Section 1, began full operation December 9, 1997. It occupies an existing detention area associated with United States Sugar Corp.'s (USSC) Southern Division Ranch, Unit 2 development, except for 1 acre that is within the adjacent Rotenberger Tract. STA-6 provides a total effective treatment area of approximately 870 acres. The source of water for STA-6 comes solely from USSC's Unit 2 pump station G600.

Phosphorus Concentrations

For the third quarter of 2000, the flow-weighted mean total phosphorus concentrations at the inflow averaged 79 ppb and 22 ppb at the outflow. The average flow-weighted mean total phosphorus concentration for the period of record at the outflow is 19 ppb, or 3.5 times lower than the average inflow concentration (**Figure 17a)**.

Phosphorus Loads

Loads from the third quarter of 2000 were 1.5 metric tons at the inflow, and 0.4 metric tons at the outflow (**Figure 17b**). The total phosphorus load reduction for the third quarter of 2000 was 77 percent. The overall total phosphorus load has been reduced by 78 percent since the project began in December, 1997.

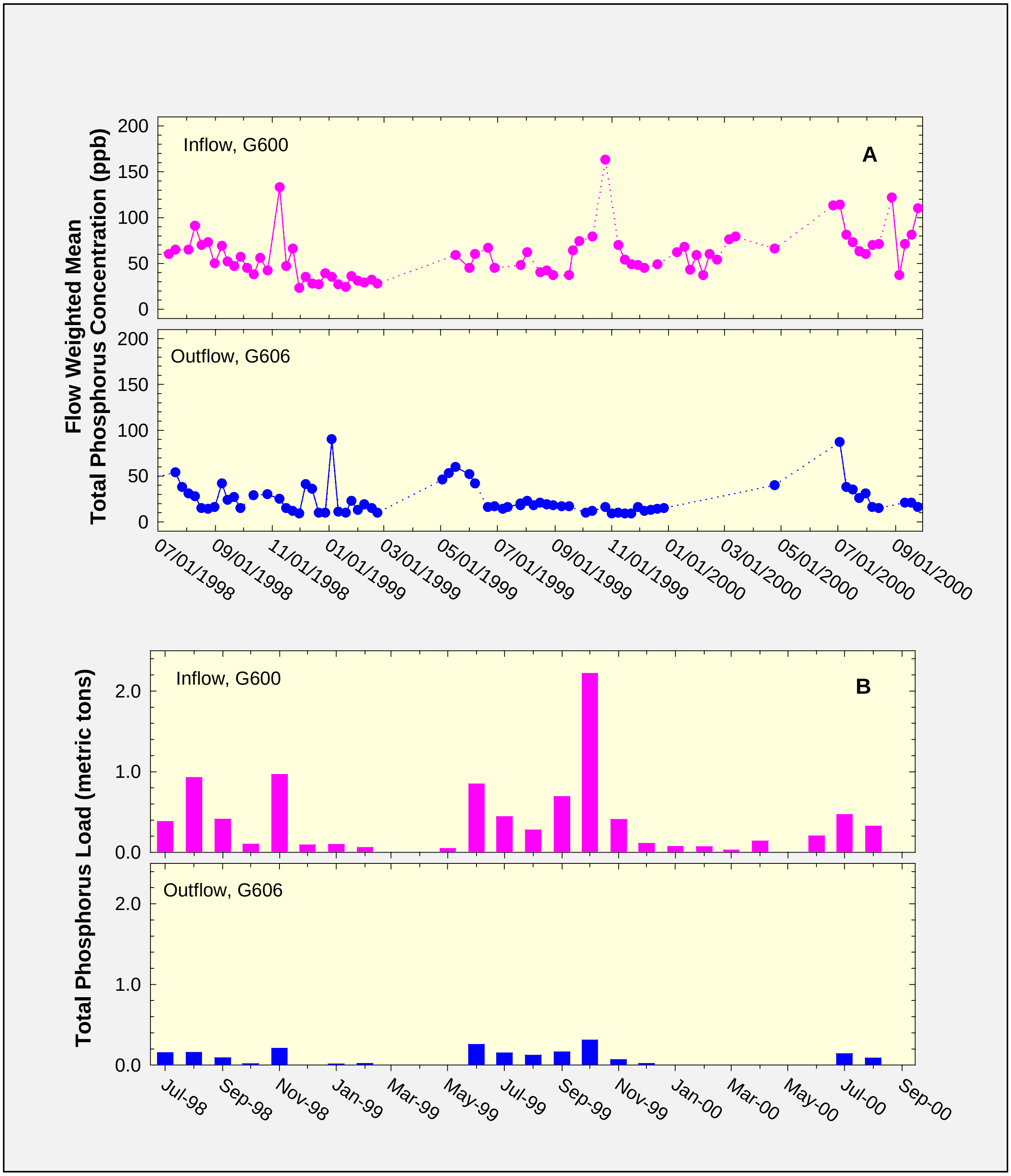

Figure 17. **a.** Weekly flow-weighted mean total phosphorus concentrations at inflow and outflow sites of STA-6, Section 1 (dashed lines indicate periods of zero flow). **b.** Monthly total phosphorus load at inflow and outflow sites of STA-6, Section 1.

Mercury Levels STA-6

Routine monitoring of mercury levels at STA-6 began in the first quarter of 1998. Surface water samples for the third quarter of 2000 were collected September 13. At that time, total mercury concentrations at the inflow (G600) and the outflow (G606) were 2.8 and 3.4 ng/L, respectively **(Figure 18a)**. Concentration of total mercury was greater at the outflow than the inflow, possibly due to recent atmospheric deposition of inorganic mercury when 3.6 inches of rain fell on STA-6 from September 4 through 8. Nonetheless, concentrations of total mercury, both at the inflow and the outflow, remained below the Florida's Class III Water Quality Standard of 12 ng/L. Methylmercury concentrations at the inflow and the outflow were 0.9 and 0.74 ng/L, respectively **(Figure 18b)**. As evident from **Figures 18 a** and **b**, although reaching higher levels, observed patterns in both total mercury and methylmercury were consistent with a general trend of increasing concentrations in third and fourth quarters, which is thought to be a result of seasonal rainfall.

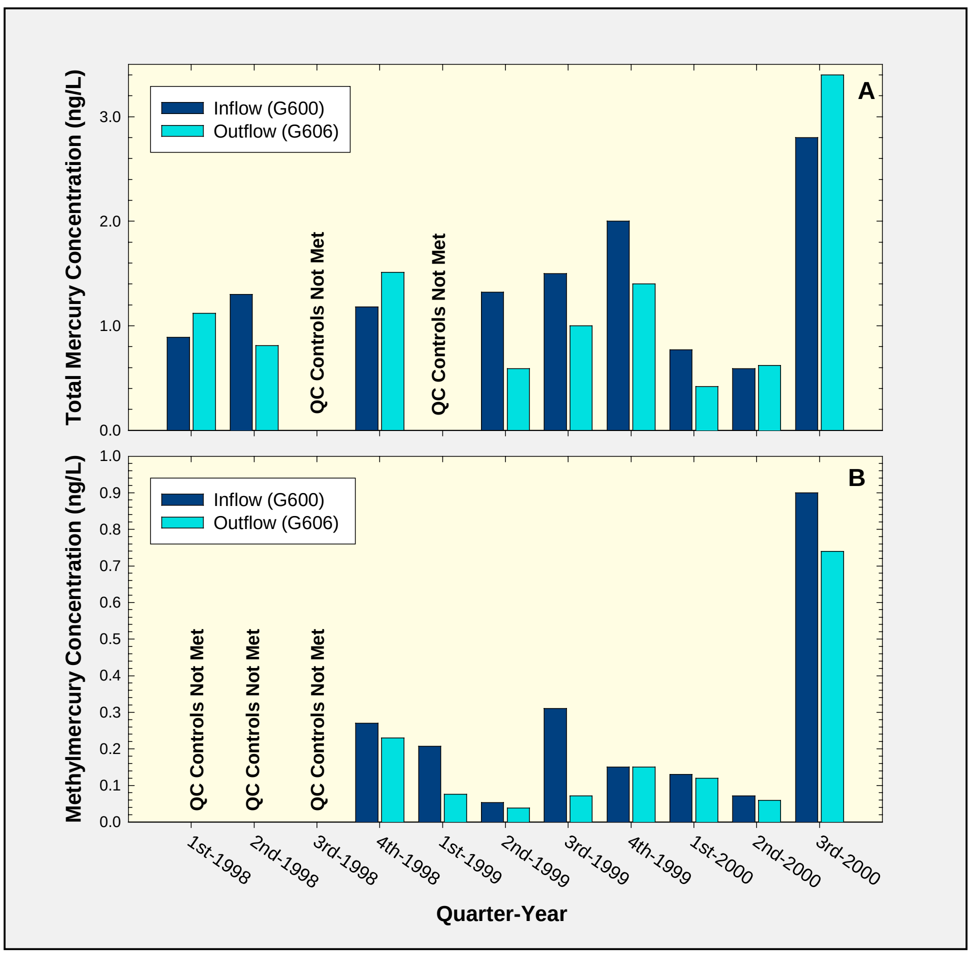

Figure 18. **a.** Quarterly surface water total mercury concentrations at inflow and outflow sites of STA-6. **b.** Quarterly surface water methylmercury concentrations inflow and outflow sites of STA-6.

Results from the annual collections of largemouth bass and sunfish are reported in the District's *2001 Everglades Consolidated Report, Chapter 7*. Mosquitofish were first collected at STA-6 in early 1998. Results from the first semiannual collection of mosquitofish in 2000 **(Figure 19)**, were first reported in the October 2000 *Environmental Conditions Update*. As previously stated, levels of mercury in mosquitofish from the inflow and outflow approached or just exceeded guidance levels suggested by the U.S. Fish and Wildlife Service (USFWS; 100 ng/g) and the U.S. Environmental Protection Agency (U.S. EPA; 77 ng/g) for the protection of fish-eating avian and mammalian wildlife. However, because there had been no appreciable discharge from STA-6 for six months, the mosquitofish in the Discharge Canal did not reflect flow from the STA and, thus, did not accurately reflect typical operation of an STA.

For more information about STA mercury monitoring permit requirements, please click here.

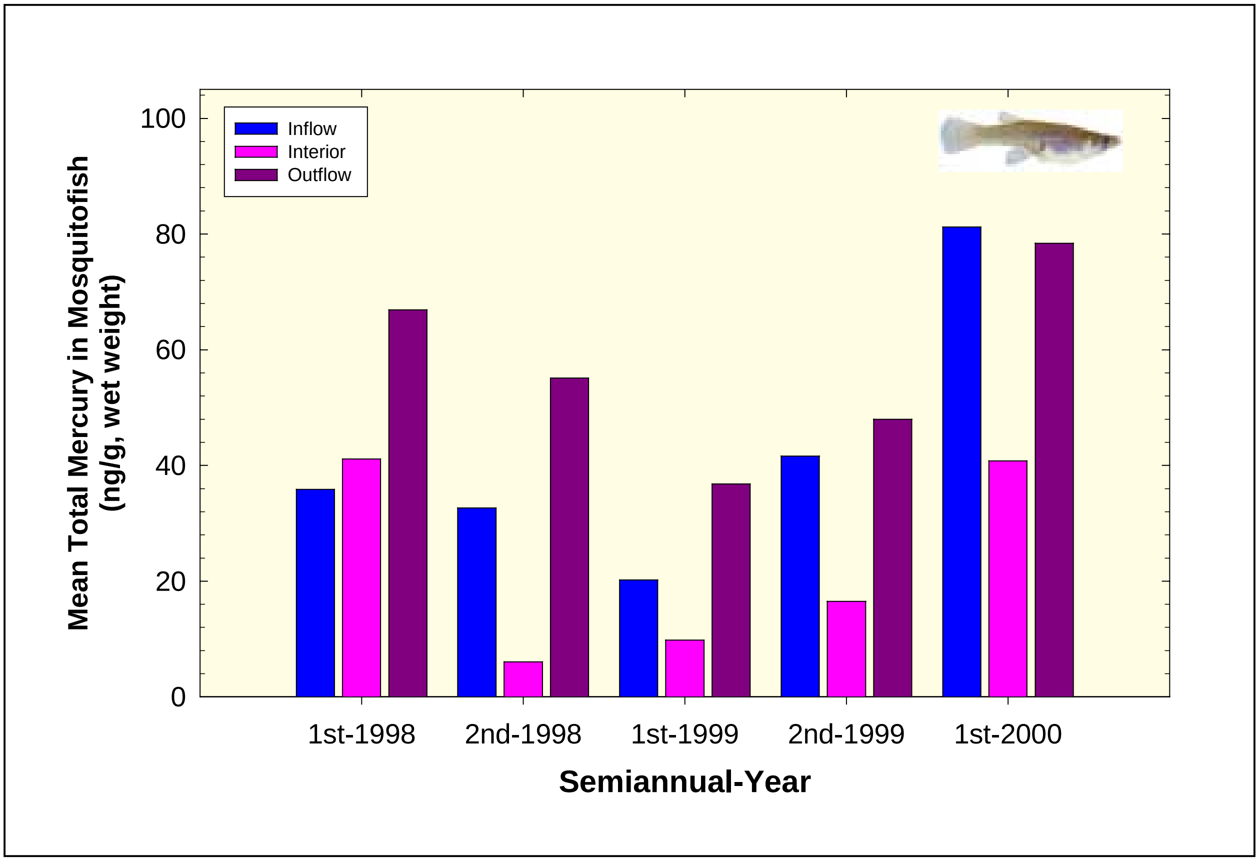

Figure 19. Mean total mercury concentrations in mosquitofish collected at the inflow, interior and outflow of STA-6.

HOLEY LAND

SUMMARY

MAP

The Holey Land Management Area (Holey Land) is a 35,000-acre tract of land that is operated as a wildlife management area by the Florida Fish and Wildlife Conservation Commission (FFWCC). A Memorandum of Agreement between the Florida Department of Environmental Protection (FDEP), the Board of Trustees of the Internal Improvement Trust Fund, the FFWCC and the South Florida Water Management District established an environmental restoration plan for the Holey Land. As part of the restoration plan, water quality monitoring was implemented to meet the requirements of FDEP Permit No. 06-500809209.

Water quality monitoring is conducted at six surface water inflow and outflow structures as shown in the map (click link above to view map). Nutrient inputs to the Holey Land can occur through surface water inflows from the Miami Canal (G200) and seepage return pumps (G200SD and G201).

Hydrology

The restoration effort also includes an operational plan schedule for maintaining surface water levels (schedule) within the Holey Land. During the wet season from May 15 through October 31, the schedule rises linearly from approximately 10.5 feet National Geodetic Vertical Datum (NGVD) to 12 feet NGVD. During the dry season from November 1 through May 14, the schedule declines linearly from 12 feet NGVD to 10.5 feet NGVD. Prior to 1996, the schedule was maintained between 11.5 feet and 13.5 feet NGVD. During wet years when sufficient rainfall can maintain the stage in the Holey Land according to schedule, less surface water inflow from the Miami Canal is required. The restoration plan requires the outflow structures (G204, G205 and G206) to be closed. However, unregulated flows from the outflow structures occur through seepage.

Figure 20a demonstrates the relationship between rainfall and average stage level in the Holey Land, and inflows from the Miami Canal (G200) for the period from July 1997 through September 2000. Also shown in **Figure 20a** are monthly flows into the management area.

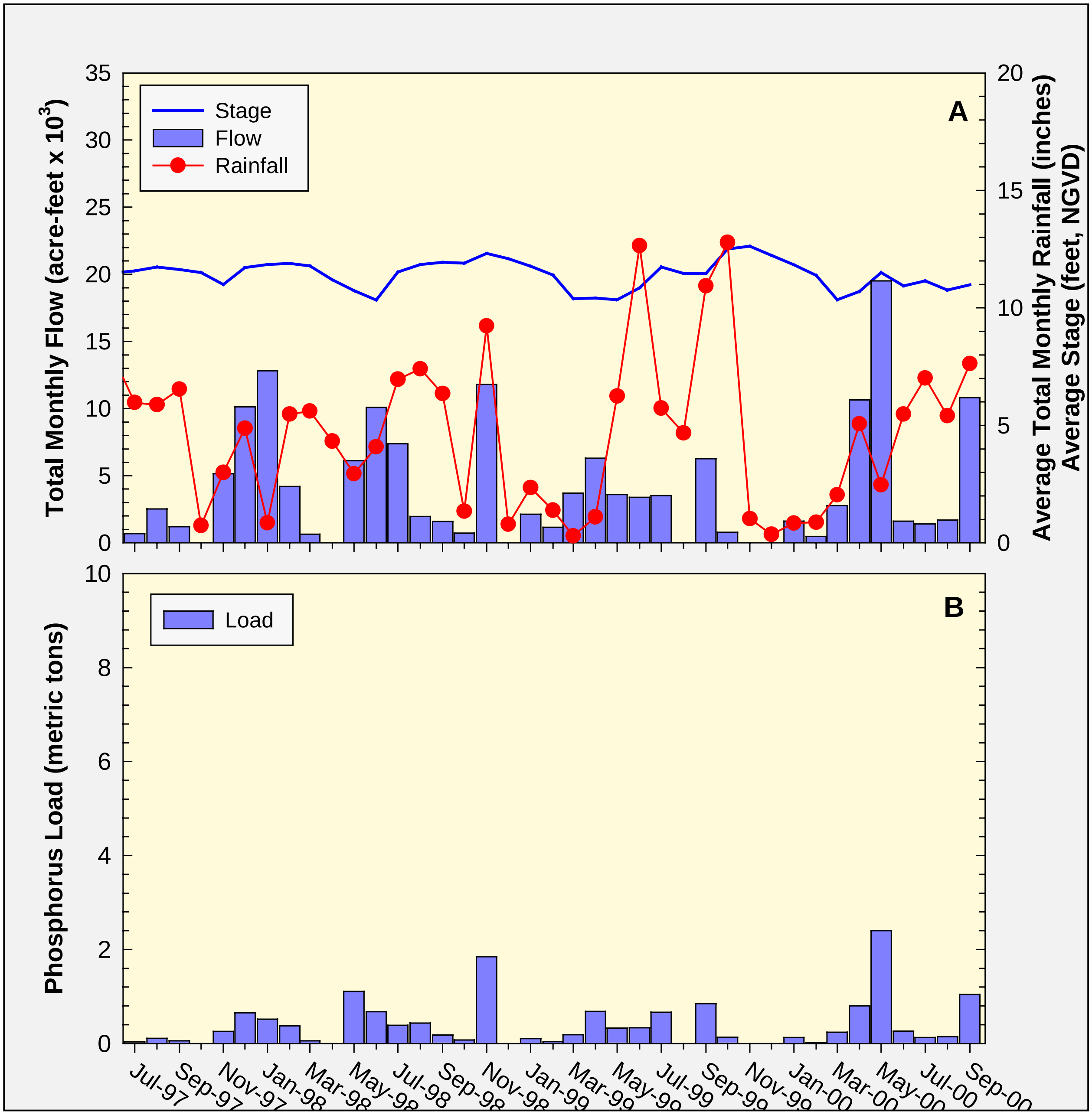

Figure 20. **a.** Flow, rainfall and stage measured at inflow station G200.
b. Phosphorus loads discharged into the Holey Land at inflow station G200.

Phosphorus Loads

Monthly phosphorus loads calculated for inflow site G200 are presented in **Figure 20b**. During the second quarter of 2000, 3.5 metric tons of phosphorus entered the Holey Land through G200. Phosphorus loads for July, August and September were 0.1, 0.1 and 1.0 metric tons, respectively. The highest phosphorus load for this period was observed in September and coincides with the highest flow and rainfall recorded for the third quarter of 2000.

The monthly load of phosphorus from July 1997 through September 2000 averaged approximately 0.4 metric tons. (**Figure 20b**). Slightly more phosphorus entered the Holey Land through G200 during the third quarter of 1999 than during the same period in 2000.

Phosphorus Concentrations

Figure 21 displays total phosphorus concentrations collected from July 1997 through September 2000 by grab and composite sampling at inflow station G200. Grab samples have been collected at G200 since July 1989, while composite samples have been collected at this site since March 1996.

The total phosphorus concentration for grab samples collected at G200 for the reporting period July 1997 through September 2000 averaged 64 parts per billion (ppb). Meanwhile, composite samples exhibited an average total phosphorus concentration of 78 ppb during the above period.

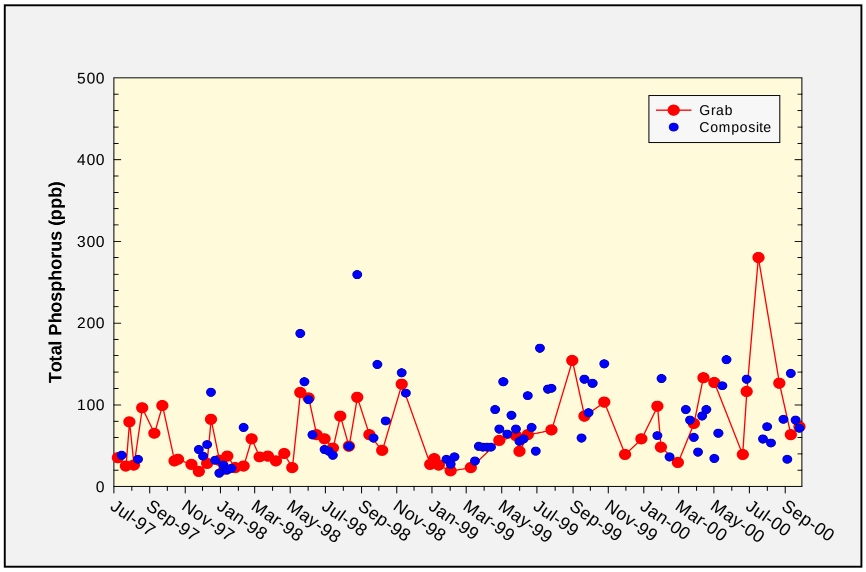

Figure 21. Total phosphorus concentrations for grab and composite samples collected at G200.

During the third quarter of 2000, total phosphorus concentrations averaged 135 ppb for grab samples and 74 ppb in composite samples. Compared with the third quarter of the previous year, total phosphorus concentrations for the present reporting period were 27 percent higher for grab samples and 50 percent lower for composite samples. **Figure 22** provides the quarterly total phosphorus levels collected at stations G204, G205 and G206. Grab sample data for these outflow stations are presented from the first quarter in 1997 through the third quarter of 2000.

A gradient in the total phosphorus concentration is evident for the three outflow stations. Phosphorus concentrations at G204 and G205 are generally higher than those at G206 (**Figure 22**). Historically, total phosphorus concentrations at G204 and G205 have averaged approximately 53 ppb compared to 14 ppb at G206. The lower total phosphorus concentrations reported for G206 might result from dilution with water from the adjacent seepage canal where the phosphorus content is lower than in the management area. The canal water is pumped into the Holey Land from seepage return pump stations G200SD and G201. Total phosphorus concentrations measured at G201 and G200SD averaged 10 ppb and 14 ppb, respectively.

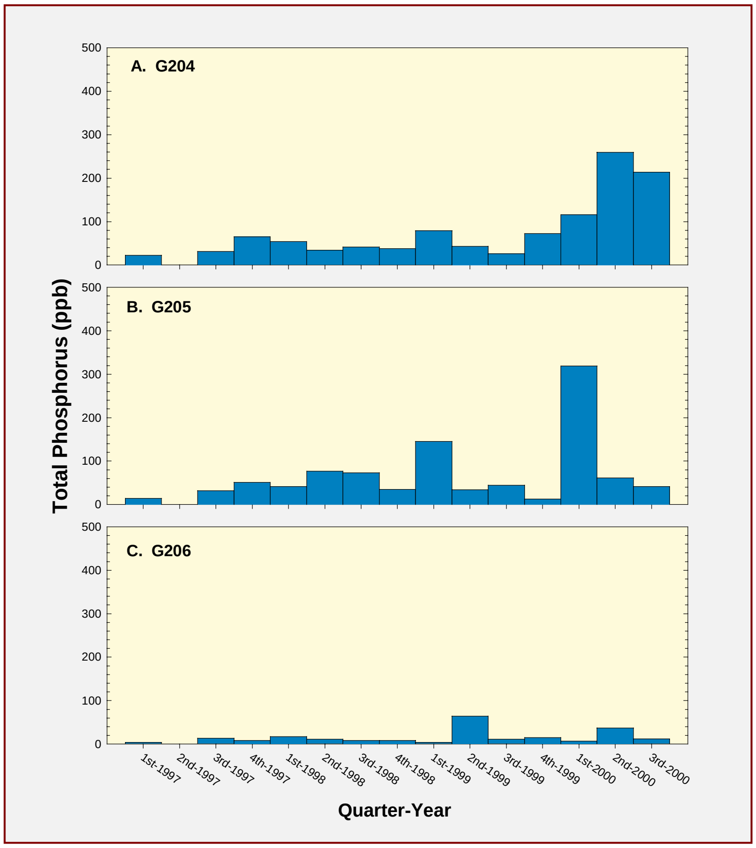

Figure 22. Quarterly total phosphorus concentrations measured for grab samples collected at outflow stations **a.** G204, **b.** G205 and **c.** G206.

ARTHUR R. MARSHALL LOXAHATCHEE NATIONAL WILDLIFE REFUGE

SUMMARY

MAP

Phosphorus Concentrations

The Settlement Agreement entered into by the federal government, the State of Florida and the South Florida Water Management District in 1991 to end the Everglades lawsuit stipulates interim and long-term phosphorus concentrations for the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge). The interim and long-term concentrations must be met by February 1, 1999, and December 31, 2006, respectively. These stipulated concentrations vary monthly because they were computed as a function of water level measured at gaging stations 1-7, 1-8C and 1-9 within the Refuge. Total phosphorus concentrations are determined from water samples collected at the 14 interior marsh stations shown on the map.

Average stages in the Refuge were 15.83 feet in July, 16.14 feet in August and 16.22 feet in September (**Figure 23**). The geometric means calculated from total phosphorus concentrations measured in water samples collected in July, August and September were 10.8, 9.4 and 10.2 ppb, respectively. These geometric mean concentrations were less than the calculated interim and long-term limits for each respective month (**Figure 23**). The interim limits for July, August and September were 17.0, 14.1 and 13.5 ppb, respectively, while the long-term limits for these same months were 13.7, 11.6 and 11.1 ppb, respectively.

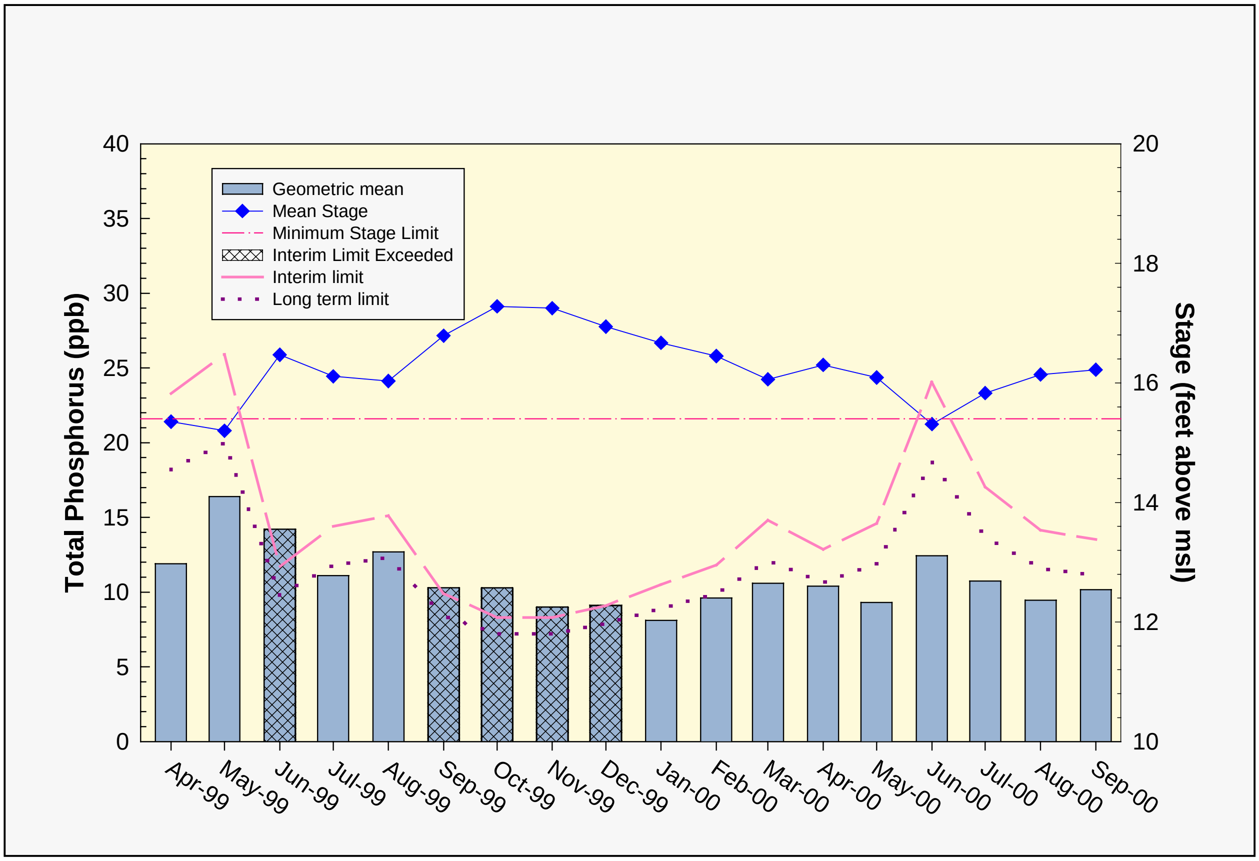

Figure 23. Monthly total phosphorus geometric mean concentrations for the Loxahatchee National Wildlife Refuge compared to the interim and long-term targets. The calculated target concentrations are adjusted for fluctuations in water level.

EVERGLADES NATIONAL PARK

SUMMARY

MAP

Shark River Slough

The Settlement Agreement of 1991 set separate interim and long-term total phosphorus concentration limits for discharges into the Everglades National Park through Shark River Slough to be met by October 1, 2003, and December 31, 2006, respectively. The limits apply to the water year ending September 30. The long-term total phosphorus concentration limit for inflows to Shark River Slough through structures S12A, S12B, S12C, S12D and S333 represents the concentrations delivered during the Outstanding Florida Waters baseline period of March 1, 1978, to March 1, 1979, and is adjusted for variations in flow. In addition, the Settlement Agreement requires that phosphorus concentrations be presented as 12-month moving flow-weighted means.

Inflow concentrations of total phosphorus through Shark River Slough are compared to the interim and long-term limits at the end of each water year from 1989 to 2000 (**Figure 24a**). The 12-month moving flow-weighted mean total phosphorus concentration ending September 2000 was 10.0 ppb. Corresponding interim and long-term limits were 9.4 and 7.6 ppb, respectively. This is the first time since 1993 that both limits were exceeded for the water year ending in September.

Table 5 presents the moving flow-weighted mean concentrations for each 12-month period beginning with September 1998 as well as the corresponding interim and long-term total phosphorus concentration limits, which are calculated using the 12-month period flow. For the 12-month periods ending in July, August and September 2000, the flow-weighted mean total phosphorus concentrations were 9.8, 9.8 and 10.0 ppb, respectively. These concentrations were all greater than the interim and long-term limits for these respective months.

The Settlement Agreement stipulates that the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed an allowable value based on flow into Shark River Slough for the same 12-month period (**Figure 24b**). For the 12-month

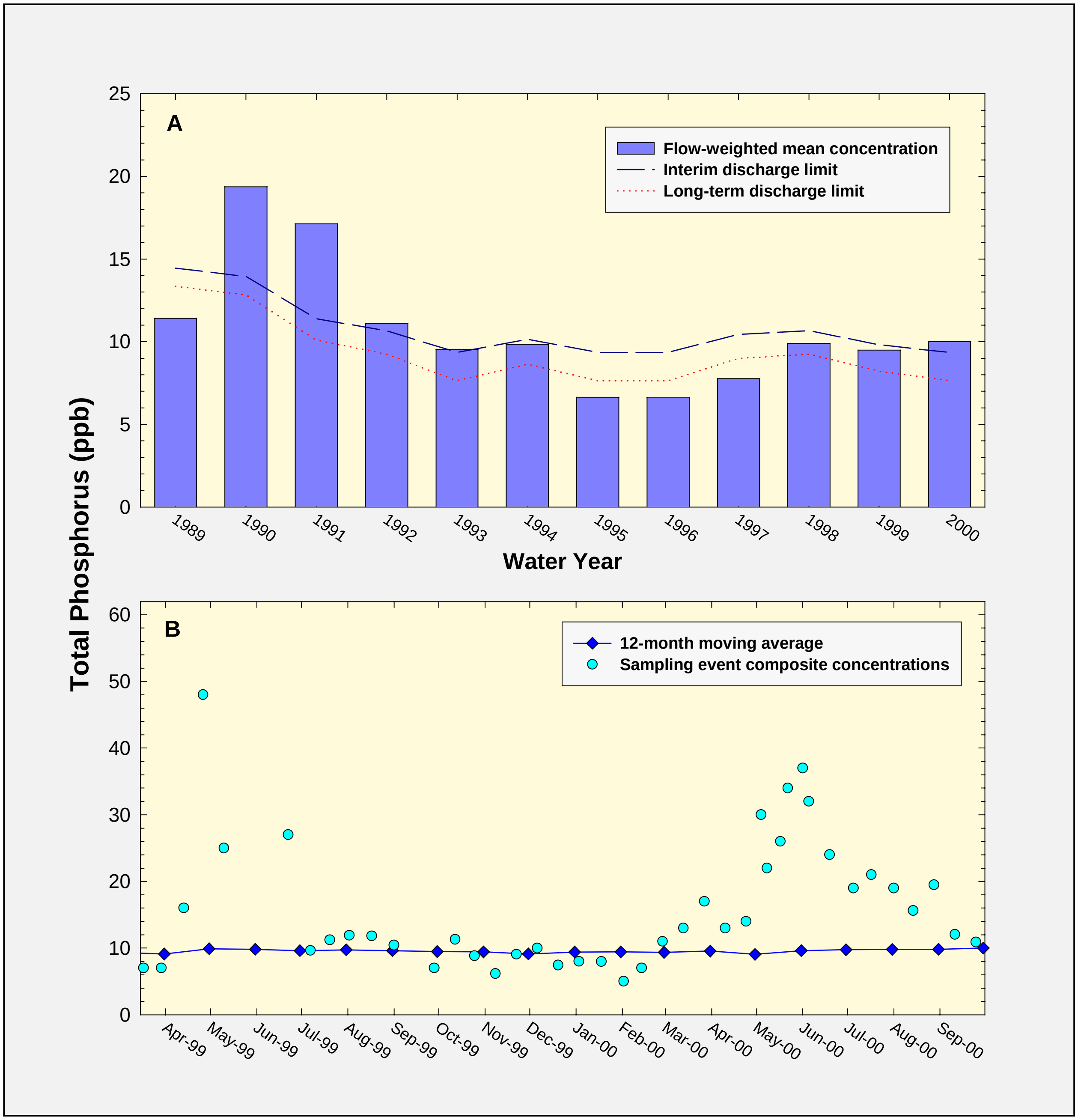

Figure 24. 12-month moving flow-weighted mean total phosphorus concentrations at the inflows to Everglades National Park (ENP) through Shark River Slough compared to the interim and long-term targets. **a.** Concentration at the end of each water year. **b.** 12-month moving average concentration at the end of each month and the composite concentration for each sampling event.

periods ending July, August and September 2000, the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb was 64.3, 65.5 and 72.4, respectively. These percentages exceeded the allowable limit of 40.1 percent for all three 12-month periods (**Table 5**).

Table 5. Shark River Slough Total Phosphorus Compliance Tracking.

12-Month Period Ending On	Total Period Flow (Kac-ft)	Flow Weighted Mean Total Phosphorus (ppb)	Limits (ppb)		Percent of Samples Greater Than 10 ppb (%)	
			Interim	Long Term	Observed	Allowed
9/30/98	737.6	9.8	10.7	9.2	***48.2***	48.1
10/31/98	728.2	10.4	10.7	9.3	***48.2***	48.3
11/30/98	772.4	10.3	10.5	9.1	***48.2***	47.1
12/31/98	871.4	9.7	10.1	8.6	***46.4***	44.5
1/31/99	852.7	9.4	10.2	8.7	42.9	45.0
2/28/99	842.9	9.3	10.2	8.7	44.4	45.3
3/31/99	826.7	9.1	10.3	8.8	40.7	45.7
4/30/99	750.3	9.9	10.6	9.2	***48.2***	47.7
5/31/99	674.6	9.8	11.0	9.6	48.0	49.9
6/30/99	680.2	9.6	10.9	9.6	40.9	49.7
7/31/99	788.4	9.7	10.4	9.0	45.8	46.7
8/31/99	857.6	9.6	10.1	8.6	43.5	44.9
9/30/99	939.9	9.5	9.8	8.2	43.5	42.9
10/31/99	1084	9.4	9.4	7.6	47.8	40.1
11/30/99	1298	9.1	9.4	7.6	47.8	40.1
12/31/99	1345	9.4	9.4	7.6	47.8	40.1
1/31/00	1395	9.4	9.4	7.6	47.8	40.1
2/29/00	1415	9.4	9.4	7.6	***50.0***	40.1
3/31/00	1386	9.6	9.4	7.6	***60.9***	40.1
4/30/00	1385	9.1	9.4	7.6	***59.1***	40.1
5/31/00	1401	9.6	9.4	7.6	***64.0***	40.1
6/30/00	1396	9.8	9.4	7.6	***66.7***	40.1
7/31/00	1295	9.8	9.4	7.6	***64.3***	40.1
8/31/00	1215	9.8	9.4	7.6	***65.5***	40.1
9/30/00	1096	10.0	9.4	7.6	***72.4***	40.1

Bold and italicized values exceeded allowed percentage

The daily mean flows through the individual Shark River Slough structures and S334 from April 1999 through September 2000 are presented in **Figure 25a**. As indicated in **Figure 25a**, the majority of flow in July entered northeastern Shark River Slough through S333. Flow through S12D began on July 23 and continued through September 30. S12C had flow from August 9 through August 25 and again from September 26 through 30. S12A and B only had flow from August 23 through 25. The relationship between the sum of the daily mean flows at Shark River Slough structures and the corresponding flow-weighted mean total phosphorus concentrations for individual sampling events is presented in **Figure 25b**. As described in the October edition of this report, the higher total phosphorus concentrations (up to 37 ppb) collected in samples at S333 in May and June 2000 reflected water released from Lake Okeechobee as the lake was being lowered. By the end of September 2000, flows entering Shark River Slough had decreasing composite total phosphorus concentrations approaching 10 ppb.

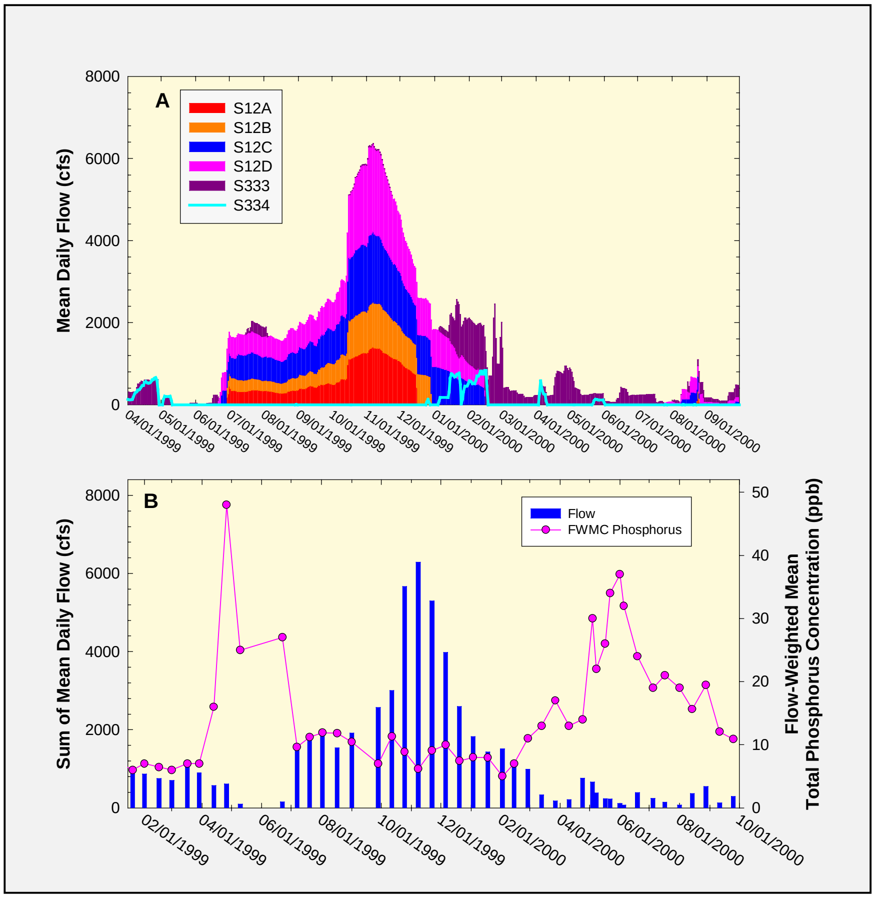

Figure 25. **a.** Mean daily flows into Shark River Slough by structure. **b.** The relationship between sum of mean daily flow at Shark River Slough structures and flow-weighted mean total phosphorus concentration for individual sampling events.

Taylor Slough and The Coastal Basins

Under the Settlement Agreement, a single total phosphorus long-term limit of 11 ppb, to be met by December 31, 2006, was set for the two points of inflow to Taylor Slough (S332 and S175) and the inflow point to the Coastal Basins (S18C). The 11 ppb limit applies to the water year ending September 30. Beginning in August 1999, structure S332D, a new pump station constructed by the U.S. Army Corps of Engineers, began operation. The structure is adjacent to spillway S174 and pumps water from the L31N canal into the L31W canal. The S332D and S174 structures became the new inflow compliance monitoring sites for Taylor Slough on October 1, 1999, replacing S332 and S175. However, the Settlement Agreement's Technical Oversight Committee requested that data from both the old and new pairs of inflow structures to Taylor Slough be presented for one year. This request was made to determine if the differences between the two data sets observed from August 1999 through March 2000 would continue throughout a complete wet season/dry season cycle and what implications this might have on future compliance with the 11 ppb limit.

Inflow concentrations of total phosphorus to the Everglades National Park through Taylor Slough and the Coastal Basins are compared to the 11 ppb limit at the end of each water year using data from both the old (S175, S332, S18C) and new (S174, S332D, S18C) combinations of structures for the 2000 water year (**Figure 26a**). The bars in **Figure 26a** represent the flow-weighted mean total phosphorus concentrations from S332, S175 and S18C for water years 1989 through 2000. The diamond point value for water year 1999 represents the total phosphorus concentrations for S174 and S18C from October 1, 1998, through September 30, 1999, plus the S332D data from August 30, 1999, through September 30, 1999. The diamond point value for 2000 represents total phosphorus concentrations for the entire year from S174, S332D and S18C.

Figure 26b presents the 12-month moving average and individual sampling event flow-weighted mean total phosphorus concentrations at both the old and new combinations of structures. The individual sampling event data for the new combination had been generally greater than those from the old combination through June 2000. From July through September 2000 the individual sampling event data from the new combination has been consistently lower than the old combination. As discussed below, flow into Taylor Slough after July 5 was only through S332D and the old combination was represented only by S18C.

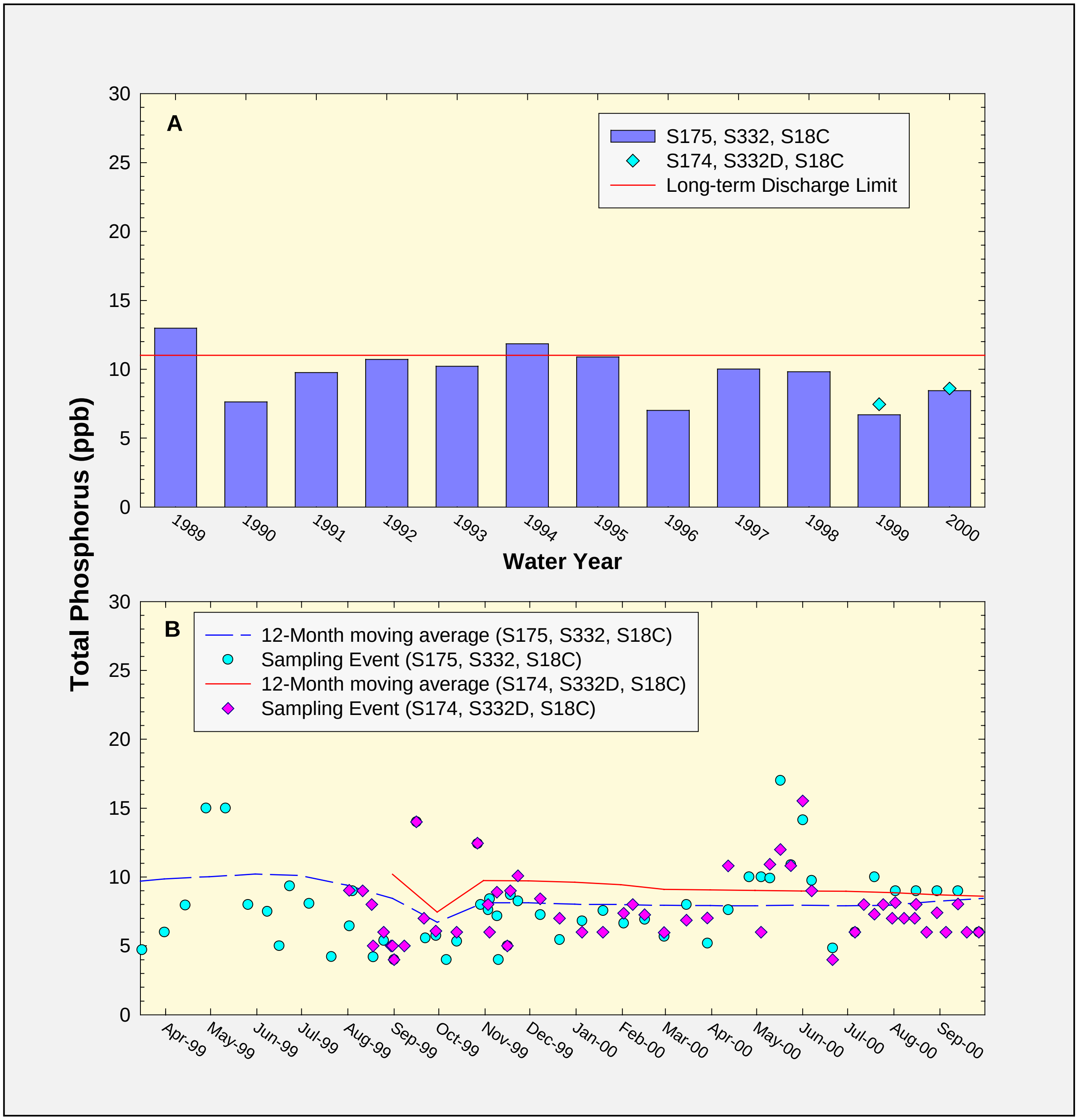

Figure 26. **a.** Flow-weighted mean total phosphorus concentration at the inflows to Everglades National Park through Taylor Slough and the Coastal Basins compared to the 11 ppb long-term total phosphorus limit for each water year. **b.** The 12-month moving average and individual sampling event flow-weighted mean total phosphorus concentrations at both the old and new combinations of compliance monitoring sites.

The 12-month flow-weighted mean concentrations for July, August and September 2000 were 8.9, 8.7 and 8.6 ppb, respectively, at the new combination of structures and 8.0, 8.3 and 8.4 ppb for July, August and September, respectively, for the old combination of structures (**Table 6**). The Settlement Agreement stipulates that the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed a fixed value of 53.1 percent. The percentage of flow-weighted mean total phosphorus concentrations greater than 10 ppb for the new combination was 18.2, 18.6 and 16.7 for the periods ending July, August and September, respectively. For these same periods, the percentage for the old combination was 17.1, 18.0 and 14.3, respectively (**Table 6**).

Table 6. Taylor Slough and Coastal Basins Total Phosphorus Compliance Tracking.

12-Month Period Ending On	Total Period Flow (ac-ft x 10^3)		Flow Weighted Mean Total Phosphorus (ppb)		Long Term Limit (ppb)	Percent of Samples Greater Than 10 ppb			
						Observed (%)		Allowed (%)	
	New	Old	New	Old		New	Old	New	Old
9/30/98	81.29	294.0	11.7	10.5	11.0	33.3	32.1	53.1	53.1
10/31/98	88.04	320.8	11.5	10.0	11.0	33.3	32.1	53.1	53.1
11/30/98	96.19	354.0	11.2	9.6	11.0	33.3	32.1	53.1	53.1
12/31/98	88.36	318.7	11.6	9.9	11.0	34.6	32.1	53.1	53.1
1/31/99	97.67	329.8	11.4	9.8	11.0	30.8	28.6	53.1	53.1
2/28/99	90.69	306.5	12.0	9.6	11.0	26.9	25.0	53.1	53.1
3/31/99	82.60	272.1	12.4	9.9	11.0	23.1	21.4	53.1	53.1
4/30/99	74.57	251.6	12.9	10.0	11.0	25.9	25.0	53.1	53.1
5/31/99	63.40	232.1	13.8	10.2	11.0	32.0	28.6	53.1	53.1
6/30/99	70.04	259.5	13.6	10.1	11.0	32.0	28.6	53.1	53.1
7/31/99	75.96	275.6	12.1	9.4	11.0	25.9	25.0	53.1	53.1
8/31/99	78.96	287.7	10.2	8.5	11.0	15.6	16.7	53.1	53.1
9/30/99	94.00	279.9	7.5	6.7	11.0	11.8	12.1	53.1	53.1
10/31/99	101.7	338.8	9.7	8.1	11.0	17.1	17.1	53.1	53.1
11/30/99	111.7	365.2	9.7	8.1	11.0	15.4	15.4	53.1	53.1
12/31/99	127.2	413.6	9.6	8.0	11.0	15.0	15.4	53.1	53.1
1/31/00	144.3	450.0	9.5	8.0	11.0	15.0	15.4	53.1	53.1
2/29/00	160.0	479.2	9.1	7.9	11.0	14.3	15.0	53.1	53.1
3/31/00	164.5	485.4	9.1	7.9	11.0	14.6	15.4	53.1	53.1
4/30/00	164.8	492.7	9.0	7.9	11.0	15.0	12.8	53.1	53.1
5/31/00	170.2	493.4	9.0	8.0	11.0	16.3	14.6	53.1	53.1
6/30/00	161.7	467.3	9.0	7.9	11.0	20.9	16.7	53.1	53.1
7/31/00	172.9	456.6	8.9	8.0	11.0	18.2	17.1	53.1	53.1
8/31/00	184.2	445.1	8.7	8.3	11.0	18.6	18.0	53.1	53.1
9/30/00	188.0	432.1	8.6	8.4	11.0	16.7	14.3	53.1	53.1

New= S174+S332D+S18C data
Old = S175+S332+S18C data

A comparison of flows between the old and new combination of structures is presented in **Figure 27**.

The flow through S18C, along with the combined flows through S332 plus S175 and S332D plus S174, is presented in **Figure 27a**. The water discharged from the downstream structures, S175 and S332, is supplied through the upstream structures, S174 and S332D. After July 5, 2000 S332 and S175 were closed. Thereafter, flow into Taylor Slough was through S322D. During this reporting period flow into Taylor Slough through S174 occurred only on July 9 and July 10. **Figure 27b** shows the relationship between the sum of the daily mean flows at S18C and the Taylor Slough structures and the corresponding flow-weighted mean total phosphorus concentrations for each sampling event at both the old and new combinations of structures. After July 5, 2000, the old combination of structures was represented only by S18C.

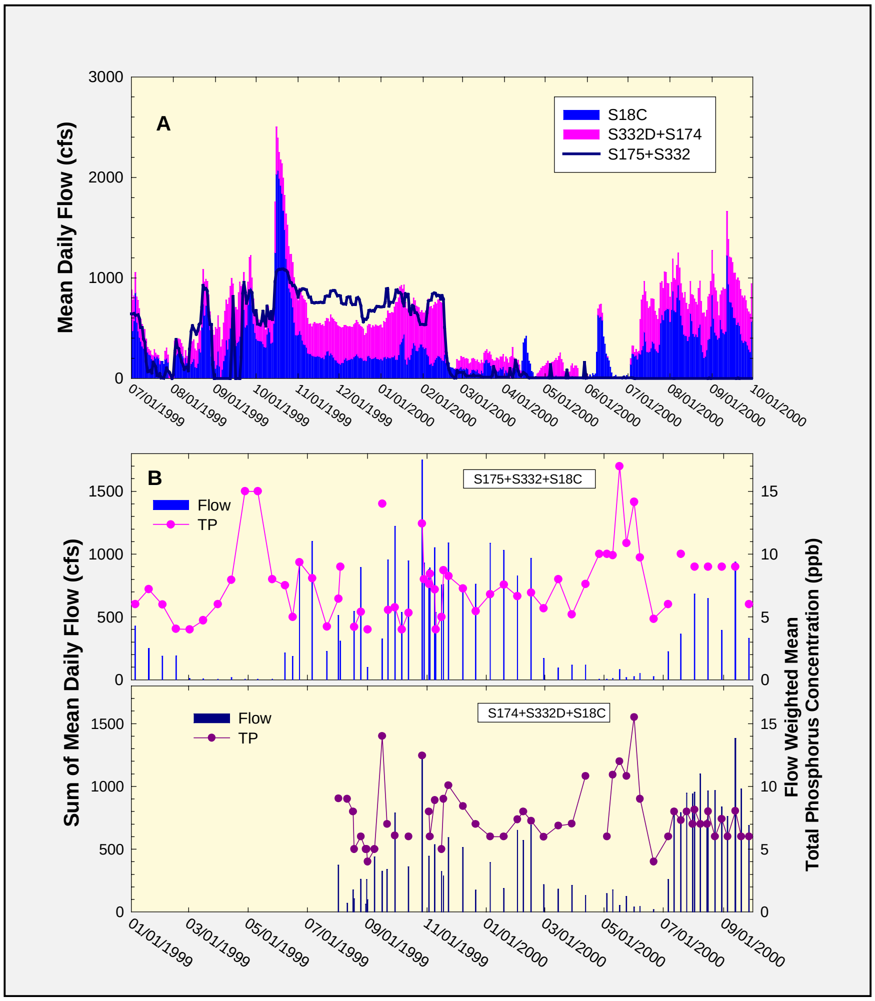

Figure 27. **a.** Daily mean flows into Everglades National Park through Taylor Slough and S18C, the Coastal Basins control structure. **b.** Mean daily flows and corresponding flow-weighted mean total phosphorus concentrations at old and new combinations of Taylor Slough and Coastal Basin structures.

FLORIDA BAY

SUMMARY

MAP

The South Florida Water Management District, in collaboration with the Everglades National Park and Florida International University, monitors water quality in Florida Bay to track the influences of fresh water inflows to the bay. Salinity and chlorophyll *a* are used as indicators of water quality within Florida Bay.

Salinity

As an estuary, Florida Bay requires a properly maintained salinity regime for the overall ecological health of the bay. Salinity can be defined as the grams of salt dissolved in a kilogram of water and is expressed in units of parts per thousand (ppt). Within the bay, salinity is affected by freshwater input, in the form of rainfall and surface water runoff from the Everglades, and transport of seawater into the bay predominantly from the Gulf of Mexico. Because the bay is a shallow and wide lagoon, evaporation also affects salinity levels. When evaporation exceeds freshwater input, portions of the bay can become hypersaline. Water conditions in the bay are considered hypersaline when salinity exceeds 35 ppt, which is the approximate mean salinity of ocean water. The central portion of the bay contains small basins surrounded by shallow seagrass banks that extend toward the western edge of Florida Bay. Because of the bathymetry of this region, it is especially susceptible to hypersaline conditions.

Maps showing salinity contours within Florida Bay from July through September 2000 are depicted in **Figures 28a** through **28c**. Overall, salinity in Florida Bay during the third quarter of 2000 ranged from 0.7 to 46.1 ppt.

Salinities greater than 35 ppt were observed in Florida Bay during all three months of the third quarter of 2000 (**Figures 28a** through **28c**). Bay-wide salinities measured for the third quarter averaged 33.8, 33.1 and 33.7 ppt in July, August and September, respectively. The lowest salinity during these three months was measured in July (**Figure 28a**). The highest salinity during the third quarter was measured during September (**Figure 28c**). Hypersaline conditions were predominant in the central portion of Florida Bay. The number of stations in this portion of the bay with salinities greater than 40 ppt increased throughout the third quarter. Evaporation and low freshwater input (i.e., runoff and rainfall), as well as water from the Gulf of Mexico, contributed to the higher salinities observed in the bay.

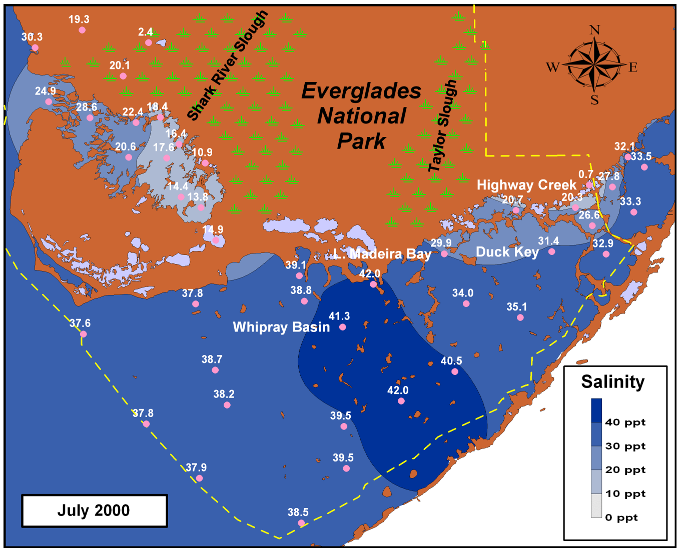

Figure 28a. Salinity in Florida Bay and the western coast of the Everglades National Park for July 2000 (Data collected by Florida International University.)

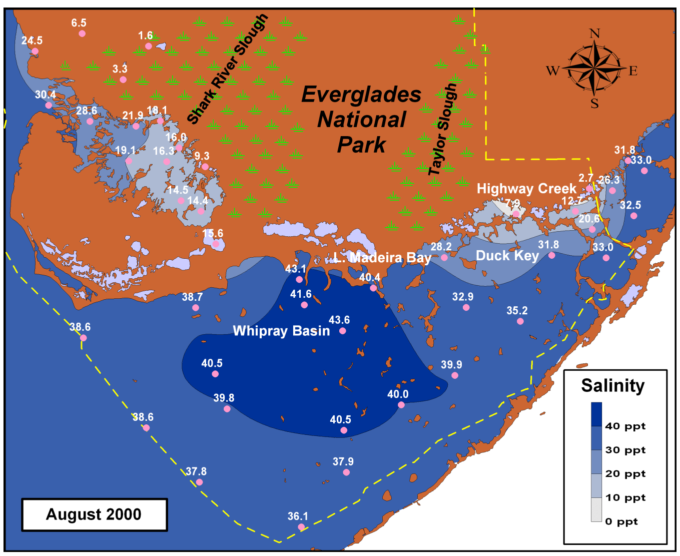

Figure 28b. Salinity in Florida Bay and the western coast of the Everglades National Park for August 2000 (Data collected by Florida International University.)

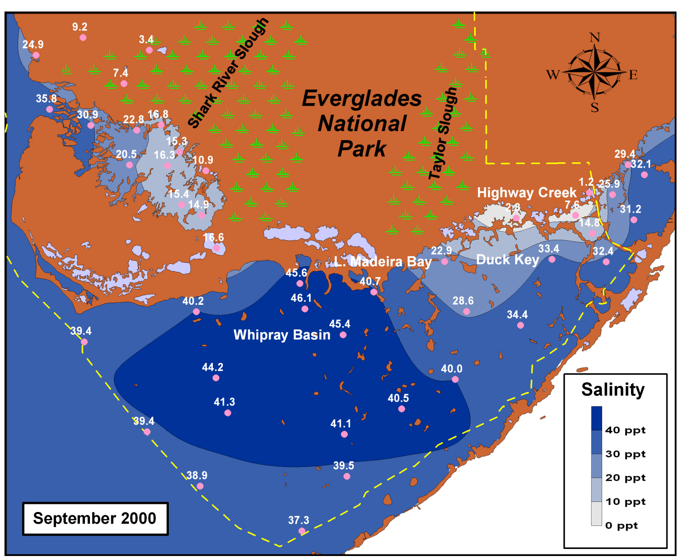

Figure 28c. Salinity in Florida Bay and the western coast of the Everglades National Park for September 2000 (Data collected by Florida International University.)

Salinity levels measured over the last three years at monitoring sites in Highway Creek, Duck Key, Little Madeira Bay and Whipray Basin are presented as **Figure 29**. A summary of salinities recorded for the third quarter of 2000 at these monitoring sites is also presented in **Table 7**. Salinities at three of the monitoring sites (Highway Creek, Duck Key and Whipray Basin) increased during the third quarter (**Figure 29**). Freshwater inflow to Little Madeira Bay through Taylor Slough resulted in a decrease in salinities at this monitoring site (**Figure 29**).

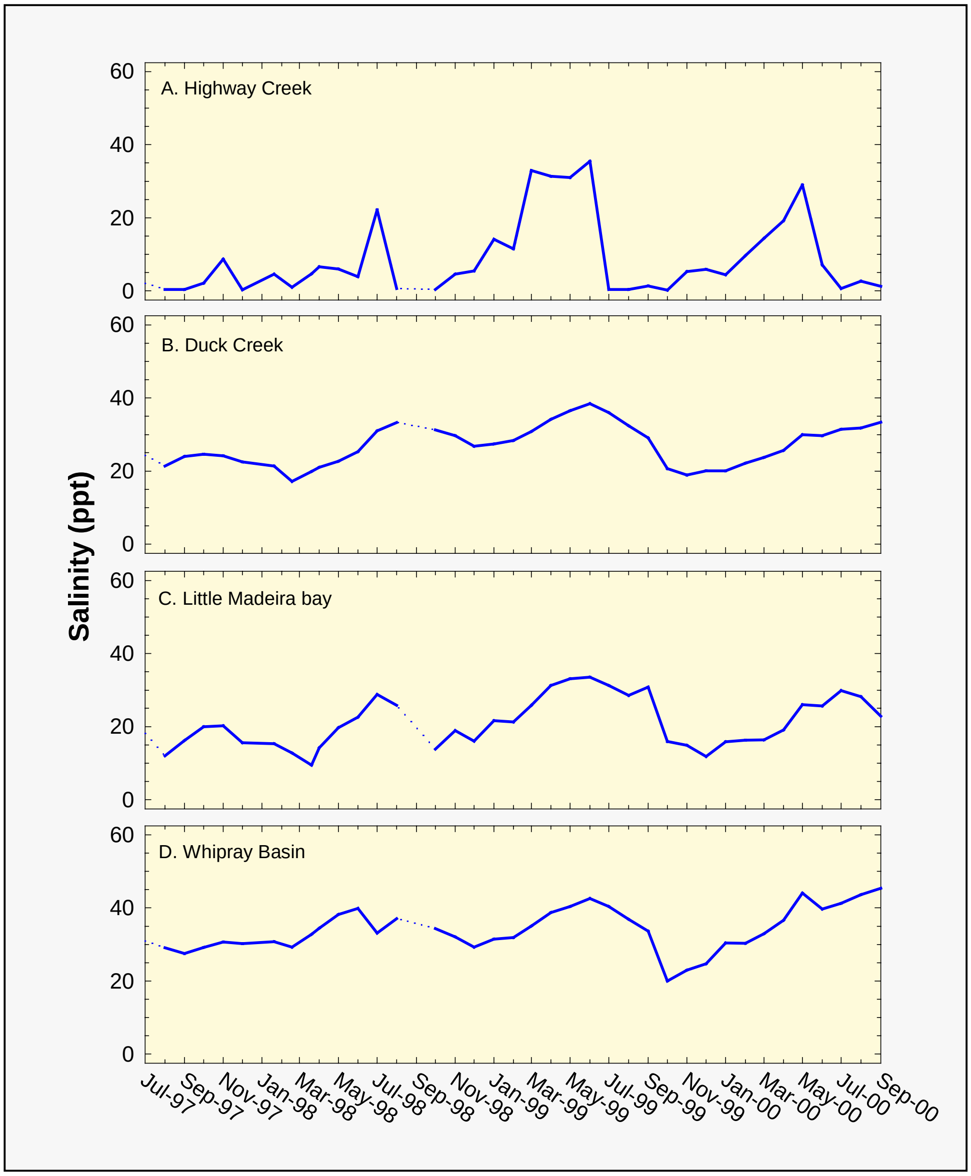

Figure 29. Salinity at four sites in Florida Bay from July 1997, through September 2000 (dashed lines indicate missing data).

Table 7. Salinity (ppt) in Florida Bay

	Jul-00	Aug-00	Sep-00
Highway Creek	0.7	2.7	1.2
Duck Key	31.5	31.8	33.4
L. Madeira Bay	29.9	28.2	22.9
Whipray Basin	41.3	43.7	45.4

Chlorophyll *a* Concentrations

Large areas of dense algal communities can affect the overall health of the Florida Bay ecosystem. Chlorophyll *a* concentrations measured in the bay are an indicator of algae (phytoplankton) biomass. Regional chlorophyll *a* concentrations in Florida Bay and the west coast of the Everglades National Park are collected monthly. The distributions of chlorophyll *a* levels measured in the bay during July, August and September are shown in **Figures 30a** through **30c.**

During the third quarter of 2000, chlorophyll *a* concentrations in Florida Bay averaged 0.9 parts per billion (ppb) and ranged from 0.1 to 8.4 ppb. Mean chlorophyll *a* concentrations in the bay increased from 0.7 ppb in July to 1.3 ppb in September 2000 (**Figure 30a** to **30c**). The eastern and southern portions of Florida Bay exhibited lower chlorophyll *a* levels. This trend has been reported in previous issues of this report. The highest chlorophyll *a* levels measured in Florida Bay during the third quarter were observed at Garfield Bight and Rankin Basin (both areas are located directly northwest of Whipray Basin)(**Figure 30c**). These higher chlorophyll *a* levels may be attributed to nutrient inputs to the bay from runoff as well as wind-induced, turbulent mixing resulting in the resuspension of sediments.

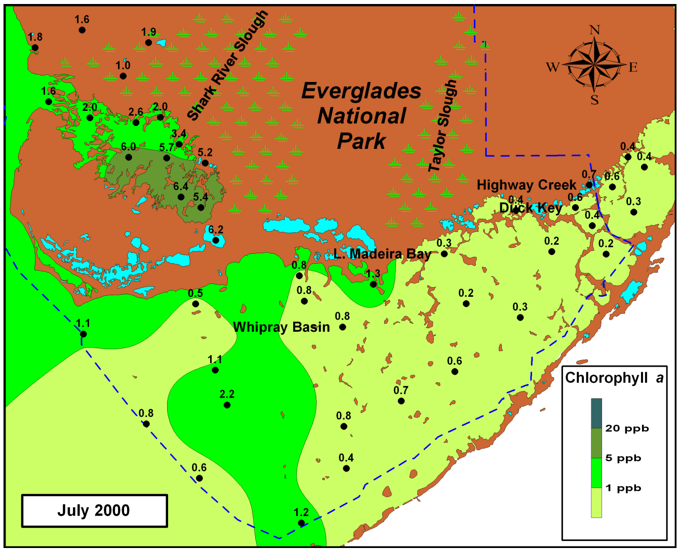

Figure 30a. Concentrations of chlorophyll *a* in Florida Bay and the western coast of Everglades National Park for July 2000. (Data collected by Florida International University.)

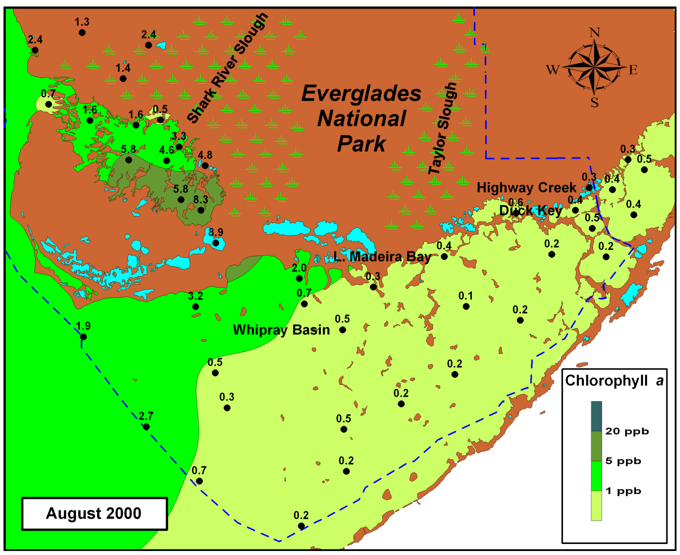

Figure 30b. Concentrations of chlorophyll *a* in Florida Bay and the western coast of Everglades National Park for August 2000. (Data collected by Florida International University.)

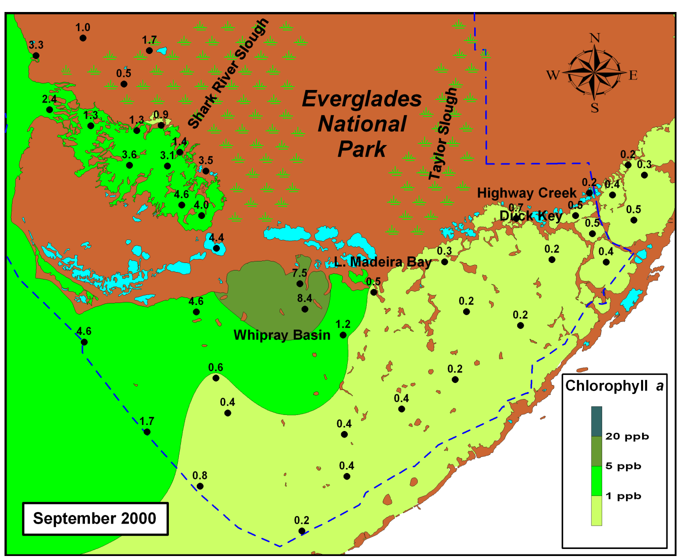

Figure 30c. Concentrations of chlorophyll *a* in Florida Bay and the western coast of Everglades National Park for September 2000. (Data collected by Florida International University.)

Chlorophyll *a* concentrations measured at four sampling stations in Florida Bay over the past three years of monitoring are shown in **Figure 31**. In addition, a summary of chlorophyll *a* concentrations measured during the third quarter of 2000 is provided in **Table 8**. In general, chlorophyll *a* levels measured at these sites during the third quarter of 2000 were similar to those measured for the same period in the previous year.

Table 8. Chlorophyll *a* (ppb) in Florida Bay

	Jul-00	Aug-00	Sep-00
Highway Creek	0.7	0.3	0.2
Duck Key	0.2	0.2	0.2
L. Madeira Bay	0.3	0.4	0.3
Whipray Basin	0.8	0.5	1.2

During third quarter of 2000, Highway Creek exhibited a decrease in chlorophyll *a* levels (**Table 8**). Meanwhile, chlorophyll *a* levels at Duck Key and Little Madeira Bay were relatively unchanged during this three-month monitoring period. Chlorophyll *a* levels at Whipray Basin, however, increased from 0.8 to 1.2 ppb (**Table 8**).

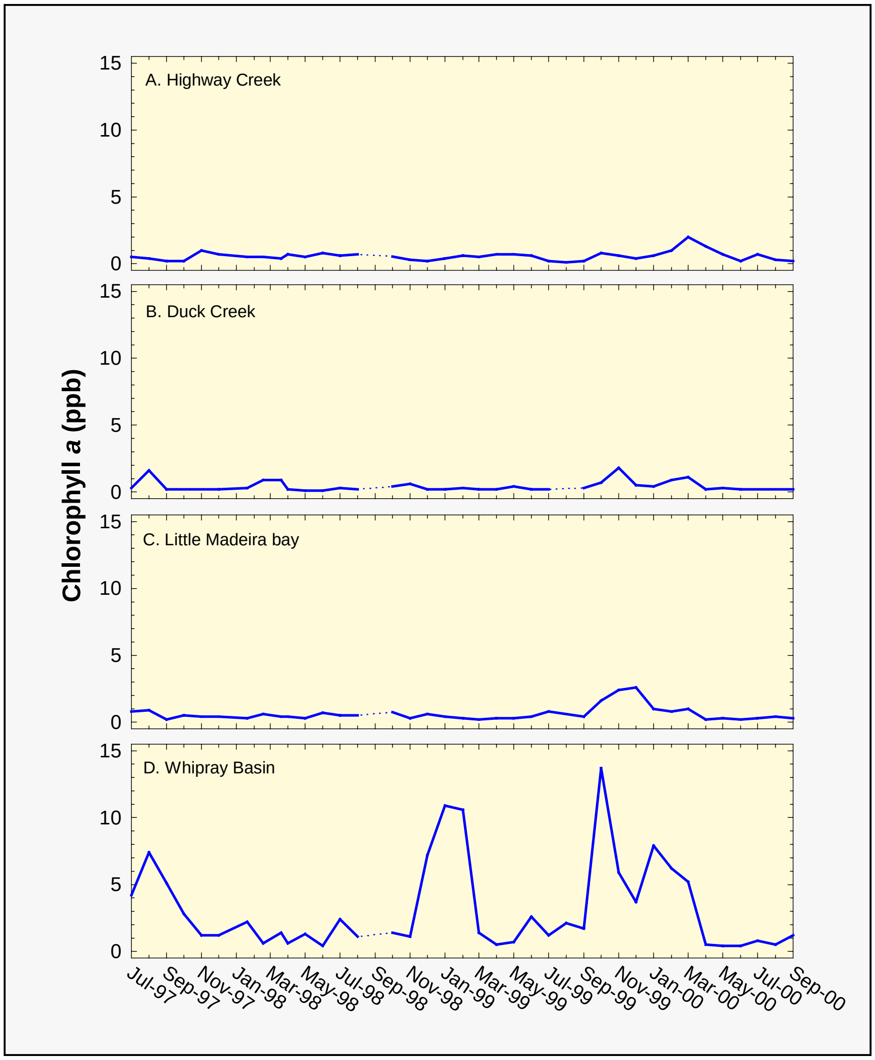

Figure 31. Chlorophyll *a* concentrations at four sites in Florida Bay from July 1997, through September 2000 (dashed lines indicate missing data).

PESTICIDE MONITORING PROGRAM

SUMMARY

MAP

As part of the District's quarterly ambient monitoring program, unfiltered water samples from 36 sites were collected from August 7 to 9, 2000, and analyzed for over 60 pesticides and/or products of their degradation. The herbicides ametryn, atrazine, bromacil, hexazinone, metolachlor, norflurazon, and simazine, along with the insecticides/degradates atrazine desethyl, atrazine desisopropyl, diazinon, and ethion were detected in one or more of these surface water samples.

The District's pesticide monitoring network includes stations designated in the Everglades National Park Memorandum of Agreement, the Miccosukee Tribe Memorandum of Agreement, the Lake Okeechobee Operating Permit, and the non-Everglades Construction Project (non-ECP) permit. The District's canals and marshes are protected as Class III (fishable and swimable) waters, while Lake Okeechobee is protected as a Class I drinking water supply. Water Conservation Area 1 (WCA-1) and the Everglades National Park are also designated as Outstanding Florida Waters, to which anti-degradation standards apply. Surface water and sediment are sampled quarterly and semiannually, respectively, upstream at each structure identified in the permit.

Surface Water Findings

At least one pesticide was detected in surface water at 34 of the 36 sites. The concentrations of the pesticides detected at each of the sites are summarized for the surface water in **Table 9**. All of these compounds have previously been detected in this monitoring program.

The diazinon concentration detected (0.060 µg/L at S38B), should not have an acute, detrimental impact for fish. However, for aquatic invertebrates, this level is slightly greater than the calculated chronic toxicity (0.04 µg/L) for *Daphnia magna*, a sensitive indicator species for aquatic macroinvertebrates. At this concentration, long term exposure can cause impacts to the macroinvertebrate populations, but the pulsed nature of urban and agricultural runoff releases to the canal system precludes drawing any conclusions about long term average exposures.

The ethion concentrations of 0.030 and 0.032 (μg/L at S99 and GORDYRD, respectively, approached the 48-hour EC_{50} of 0.06 μg/L reported for *Daphnia magna*, a sensitive indicator species for aquatic macroinvertebrates. EC_{50} is a concentration necessary for 50 percent of the aquatic species tested to exhibit a toxic effect short of mortality within a short exposure period, usually 24 to 96 hours. However, these concentrations did exceed the acute (0.02 (μg/L) and chronic toxicity level (0.003 (μg/L) for *Daphnia magna* calculated according to promulgated procedure (FAC 62-302.200). At this level, either short- or long-term exposure can cause impacts to macroinvertebrate populations, but the pulsed nature of agricultural runoff releases to the canal system precludes drawing any conclusions about average exposures.

The above findings must be considered with the caveat that pesticide concentrations in surface water and sediment may vary significantly in relation to the timing and magnitude of pesticide application, rainfall events, pumping and other factors, and that this was only one sampling event. The possible long term or chronic toxicity impacts are also reported based on the single sampling event and do not take into account previous monitoring data.

Table 9. Summary of pesticide residues above the method detection limit found in surface water samples collected by the District in August 2000.

DATE	SITE	FLOW	COMPOUNDS (µg/L) ametryn	atrazine	atrazine desethyl	atrazine desisopropyl	bromacil	diazinon	ethion	hexazinone	metolachlor	norflurazon	simazine	Number of compounds detected at site
8/07/00	S18C	Y	-	0.022 I*	-	-	-	-	-	-	-	-	-	1
	S178	N	-	0.025 I	-	-	-	-	-	-	-	-	-	1
	S177	Y	-	0.024 I	-	-	-	-	-	-	-	-	-	1
	S332	N	-	0.024 I	-	-	-	-	-	-	-	-	-	1
	S176	Y	-	0.027 I	-	-	-	-	-	-	-	-	-	1
	S331	Y	-	0.021 I	-	-	-	-	-	-	-	-	-	1
	G211	Y	-	-	-	-	-	-	-	-	-	-	-	0
8/08/00	US41-25	Y	-	-	-	-	-	-	-	-	0.012 I	-	-	1
	S12C	N	0.013 I	0.11	0.012 I	-	-	-	-	-	-	-	-	3
	S31	N	-	0.040 I	-	-	-	-	-	-	-	-	-	1
	S9	Y	-	0.15	0.015 I	-	-	-	-	-	-	-	-	2
	G123	N	-	0.069 *	-	-	-	-	-	-	-	-	-	1
	S142	N	0.020 I	0.064	0.010 I	-	-	-	-	-	-	-	-	3
	S140	Y	-	-	-	-	0.19 I	-	-	0.34	-	0.079 I	-	3
	S38B	N	0.012 I	1.5	0.14	-	-	0.060 I	-	-	-	-	-	4
	C255S99	Y	-	-	-	0.027 I	0.44	-	0.030 I	-	-	1.1	0.42	5
	GORDYR	Y	-	-	-	0.031 I	0.81	-	0.032 I	-	0.090 I	1.8	0.31	6
	S80	N	-	-	-	0.011 I	-	-	-	-	-	0.46	0.45	3
	S191	N	-	-		-	0.048 I	-	-	-	-	0.039 I	0.050	3
	S65E	Y	-	0.035 *I	-	-	0.065 *I	-	-	-	-	-	0.034 *I	3
	FECSR78	Y	-	-	-	-	-	-	-	-	-	-	-	0
8/09/00	S190	N	-	0.15 *	0.028	-	0.45 *	-	-	-	-	0.088 *I	-	4
	L3BRS	N	0.025 I	0.10	0.020	-	-	-	-	-	-	-	-	3
	S8	Y	-	0.14	0.017 I	-	-	-	-	-	-	-	-	2
	S7	Y	0.049	0.11	0.016	-	-	-	-	-	-	-	-	3
	S6	Y	0.078	0.082	0.011	-	-	-	-	0.032 I	-	-	-	4
	G94D	N	0.040 I	0.15	0.014	-	-	-	-	0.045 I	-	-	-	4
	ACME1D	N	-	0.18	0.017 I	-	-	-	-	0.065 I	-	-	-	3
	S5A	Y	-	-	-	-	0.048 I	-	-	-	-	-	-	1
	S79	N	0.019 I	0.22	0.022 I	0.015 I	1.2	-	-	-	0.13 I	0.36	0.17	8
	CR33.5T	Y	-	1.1	0.044 I	0.041 I	3.6	-	-	-	1.2	0.84	0.51	7
	S78	N	-	-	0.021	0.011 *I	-	-	-	0.025 *I	-	0.33 *	0.044 *I	5
	S235	N	0.058	0.25	0.032	0.035 I	1.1	-	-	-	-	0.23	0.45	7
	S4	N	0.13	0.090	-	-	-	-	-	0.021 I	-	-	-	3
	S3	N	0.041 I	0.074	0.010	-	-	-	-	-	-	-	-	3
	S2	**N**	0.27	0.078	0.012 I	-	-	-	-	-	-	-	-	3
Total number of compound detections			**12**	**26**	**17**	**7**	**10**	**1**	**2**	**6**	**4**	**10**	**9**	

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GLOSSARY

12-month moving average
The mean (arithmetic average) of data from 12 consecutive months. As the latest month is added to the data set, the earliest month is dropped from the data set

5-year moving average
The mean (arithmetic average) of data from 5 consecutive annual averages of sums. When the latest year is added to the data set the earliest year is dropped from the data set.

flow-weighted mean

The arithmetic average adjusted for flow:

$$\bar{x} = \frac{\left(\sum_{i=1}^{i=n} q_i c_i\right)}{\left(\sum_{i=1}^{i=n} q_i\right)}$$

q = flow
c = concentration

geometric mean

The nth root of individual data values that have been multiplied:

$$G = \sqrt[n]{x_1 x_2 .... x_n}$$

EC_{50}
A concentration necessary for 50 percent of the aquatic species tested to exhibit a toxic effect short of mortality within a short exposure period, usually 24 to 96 hours.

units of concentration measurement
(assuming density of water = 1.0)

grams/kilograms	(g/kg) =	1 part /thousand (ppt)
milligram/Liter	(mg/L) =	1 part/million (ppm)
microgram/Liter	(µg/L) =	1 part/billion (ppb)
nanogram/Liter	(ng/L)	

FOR MORE INFORMATION

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